REPORT No. 157

NOMENCLATURE FOR AERONAUTICS

BY NATIONAL ADVISORY COMMITTEE
FOR AERONAUTICS

INTRODUCTION.

The Nomenclature for Aeronautics presented in this Report No. 157 is a revision of the last previous report (No. 91), published in April, 1920.

This Nomenclature for Aeronautics was prepared by a special conference on aeronautical nomenclature, composed of representatives of the Army and Navy Air Services, the Air Mail Service, the Bureau of Standards, the National Advisory Committee for Aeronautics, and private life. This conference was authorized by resolution of the executive committee of the National Advisory Committee for Aeronautics at a meeting held on January 26, 1922, at which meeting Dr. Joseph S. Ames was appointed chairman of the conference. The National Advisory Committee for Aeronautics officially invited the Chief of the Army Air Service, the Chief of the Bureau of Aeronautics of the Navy Department, the Director of the Bureau of Standards, the Second Assistant Postmaster General, the Society of Automotive Engineers, the American Society of Mechanical Engineers, and the Aeronautical Chamber of Commerce to designate representatives to serve on the conference on aeronautical nomenclature.

Members of the conference were engaged in the preparation of this report all through the spring and summer. On recommendation of the subcommittee on aerodynamics, the report was officially approved by the executive committee of the National Advisory Committee for Aeronautics on August 31, 1922.

This report supersedes all previous publications of the committee on this subject. It is published with the intention of securing greater uniformity and accuracy in official documents of the Government, and, as far as possible, in technical and other commercial publications.

The special conference on aeronautical nomenclature was organized as follows:

SPECIAL CONFERENCE ON AERONAUTICAL NOMENCLATURE.

Dr. Joseph S. Ames, *Chairman.*

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS:
- Prof. Charles F. Marvin.
- Prof. Edward P. Warner.
- Mr. F. H. Norton.

AIR SERVICE OF THE ARMY:
- Maj. Percy E. Van Nostrand, United States Army.
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- Lieut. C. N. Monteith, United States Army.

BUREAU OF AERONAUTICS, NAVY:
- Commander J. C. Hunsaker, United States Navy.
- Dr. A. F. Zahm.
- Lieut. W. S. Diehl, United States Navy.
- Mr. Starr Truscott.

AIR MAIL SERVICE:
- Mr. C. I. Stanton.

BUREAU OF STANDARDS:
- Dr. L. J. Briggs.
- Dr. H. L. Dryden.

SOCIETY OF AUTOMOTIVE ENGINEERS:
- Mr. V. E. Clark.

AERONAUTICAL CHAMBER OF COMMERCE:
- Mr. Grover C. Loening.

REPORT No. 157.

NOMENCLATURE FOR AERONAUTICS.

By the National Advisory Committee for Aeronautics.

PART I.

ALPHABETICAL NOMENCLATURE.

AERODYNAMICS.—The branch of dynamics which treats of the motion of air and other gaseous fluids, and of the forces on solids in motion relative to such fluids.

AEROFOIL.—(*See* Airfoil.)

AERONAUTICS.—The science and art of self-sustained flight in air.

AEROSTAT.—An aircraft whose support is chiefly due to buoyancy, its interior being occupied in the main by one or more bags or cells filled with a gas lighter than the surrounding air. Same as lighter-than-aircraft.

AEROSTATICS.—The science that treats of the equilibrium of gaseous fluids and of solid bodies immersed in them.

As an aeronautic term it relates to those properties of lighter-than-aircraft which are due to the buoyancy of the air.

AEROSTATION.—The art of operating lighter-than-aircraft.

AILERON.—A hinged or pivoted movable auxiliary surface of an airplane, usually part of the trailing edge of a wing, the primary function of which is to impress a rolling moment on the airplane. (Fig. 1.)

AILERON ANGLE.—(*See* Angle, aileron.)

AIR DUCT.—The duct which joins the vertical to the lateral lobes of a kite balloon; also supplies air to the ballonet blower of a semirigid airship. (Figs. 2 and 5.)

AIR ROUTE.—An aerial highway between two traffic centers, or leading from a traffic center into an airway.

AIR SCOOP.—A projecting scoop, which uses the wind or slip stream to maintain air pressure in the interior of the ballonet of an aerostat. (Figs. 2, 3, and 12.)

A similar device is sometimes used on airships to produce ventilation. (Fig. 4.)

AIRCRAFT.—Any man-carrying device or structure designed to be supported by the air, making use either of buoyancy or of the dynamic action of the air.

AIRFOIL.—A winglike structure, flat or curved, e. g., a fin, wing, aileron, rudder, etc. Its function is to cause forces to be exerted perpendicular to its surfaces by the dynamical action of the air through which it moves.

The words "control surface," "lifting surface," and "stabilizing surface" are often used to indicate an airfoil used for a specific purpose.

AIRFOIL SECTION (OR PROFILE).—A cross-section of an airfoil made by a plane perpendicular to its lateral axis.

Any definite airfoil, even when considered by itself, as in a wind-tunnel experiment, is always designed with reference to a definite position in an aircraft; certain airfoils are to be used horizontally, e. g., wings, ailerons, stabilizer, others vertically, e. g., rudders, fins. In the former case, the section (or profile) is the cross-section made by the plane of symmetry of the aircraft; in the latter, by a horizontal plane.

AIRPLANE.—A mechanically driven aircraft heavier than air, fitted with fixed wings, and supported by the dynamical action of the air.

AIRPORT.—The terminal of an airway. It provides a tract of land or water so that aircraft may alight with safety, and also offers facilities for operation, such as hangars, shops, supply depots, etc.

AIRSHIP.—An aerostat provided with a propelling system and with means of controlling the direction of motion. If its power plant is not operating, it acts like a balloon.

NONRIGID.—An airship whose form is maintained by the internal pressure in the gas bags and ballonets. (Fig. 3.)

RIGID.—An airship whose form is maintained by a rigid structure. (Fig. 4.)

SEMIRIGID.—An airship whose form is maintained by means of a rigid or jointed keel in combination with internal pressure in the gas containers and ballonets. (Fig. 5.)

AIRSPEED.—The speed of an aircraft relative to the air. Its symbol is V.

AIRSPEED INDICATOR.—An instrument for indicating the speed of aircraft relative to the air.

TRUE AIRSPEED INDICATOR.—An instrument, usually working on the principle of the Biram or Robinson anemometers, which gives the true airspeed provided the slip of the anemometer is negligible.

APPARENT AIRSPEED INDICATOR.—An instrument, usually dependent on the impact pressure of the airstream, whose readings, therefore, vary both with the true airspeed and with the density of the air.

AIRWAY.—An aerial highway, developed by the provision of landing fields, radio stations, etc., for transportation between three or more traffic centers or extending across a large geographical area.

ALTIGRAPH.—An instrument, usually the same in principle as an aneroid barometer which makes on a chart a permanent record of the altitude. The chart is usually graduated in feet or meters in accordance with some empirical pressure altitude formula.

ALTIMETER.—An aneroid barometer whose dial is marked to indicate altitude.

AMPHIBIAN.—An airplane designed to rise from and alight on either land or water.

ANEMOMETER.—An instrument for measuring directly or indirectly the velocity of the wind.

ANGLE, AILERON.—The acute angle between the aileron and the wing. It is positive when the trailing edge is pulled down.

ANGLE, CRITICAL.—An angle of attack at which the flow about an airfoil changes abruptly, with corresponding abrupt changes in the lift and drag.

ANGLE, DIHEDRAL.—The acute angle between the wing and the lateral axis of the airplane projected on a plane perpendicular to the longitudinal axis of the airplane. In certain types of wings it is necessary to specify whether the upper or the lower surface is taken, and a special definition would be required for a warped wing. If the inclination of the wing is upward, the angle is said to be positive; if downward, negative. (Fig. 1.) The several main supporting surfaces of an airplane may have different amounts of dihedral. The dihedral angle has the symbol γ.

ANGLE, DOWNWASH.—The angle through which an air stream is deflected by any lifting surface of an airplane. It is measured in a plane parallel to the plane of symmetry, and is denoted by the symbol ϵ.

ANGLE, DRIFT.—The angular deviation of an aircraft from a set course.

ANGLE, EFFECTIVE HELIX.—The angle whose tangent is the ratio of the velocity of flight to the product of the three quantities: 2π, r, the distance from the axis to the point in question, and n, the number of revolutions per second; i. e., $\Phi = \tan^{-1}\left(\frac{V}{2\pi rn}\right)$.

ANGLE, ELEVATOR.—The acute angle between the elevator and the stabilizer. It is positive when the trailing edge is pulled down.

ANGLE, GLIDING.—The acute angle between the horizontal and the path along which an airplane in ordinary flying attitude descends in still air when the propeller is giving no thrust.

ANGLE, LANDING.—The acute angle between the upper wing chord of an airplane and the horizontal when it is resting on the ground in its normal position. (Also called "Ground Angle.") (Fig. 1.)

ANGLE, RUDDER.—The acute angle between the rudder and the plane of symmetry of the aircraft. It is positive when the trailing edge moves to the left with reference to the normal position of the pilot.

ANGLE, ZERO LIFT.—The angle of attack of an airfoil when the lift is zero.

ANGLE OF ATTACK.—The acute angle between the chord of an airfoil and its direction of motion relative to the air. (This definition may be extended to other bodies than airfoils.) Its symbol is α.

ANGLE OF INCIDENCE OF WING.—(*See* Angle of wing setting.)

ANGLE OF PITCH.—The acute angle between two planes defined as follows: One plane includes the lateral axis of the aircraft and the direction of the relative wind; the other plane includes the lateral axis and the longitudinal axis. (In normal flight the angle of pitch is, then, the angle between the longitudinal axis and the direction of the relative wind.) This angle is denoted by Θ, and is positive when the nose of the aircraft rises.

ANGLE OF PROPELLER BLADE.—The acute angle between the chord of a propeller section and a plane perpendicular to the axis of rotation of the propeller. (Usually "Blade angle.")

ANGLE OF ROLL, or ANGLE OF BANK.—The acute angle through which an aircraft must be rotated about its longitudinal axis in order to bring its lateral axis into a horizontal plane. This angle is denoted by Φ, and is positive when the left wing is higher than the right.

ANGLE OF STABILIZER SETTING.—The acute angle between the chord of the lower wings of an airplane and the chord of the stabilizer. This angle is denoted by the symbol β and is positive when the stabilizer has a greater angle of incidence than the wing. (Also called "Longitudinal dihedral" or "Longitudinal V.") (Fig. 1.)

ANGLE OF WING SETTING.—The acute angle between the plane of the wing chords and the propeller axis. Its symbol is i_w. (Also called "Angle of incidence of wing.")

ANGLE OF YAW.—The acute angle between the direction of the relative wind and the plane of symmetry of an aircraft. This angle is denoted by Ψ, and is positive when the aircraft turns to the right.

ANTIDRAG WIRES.—(*See* Wires, antidrag.)

ANTILIFT WIRES.—(*See* Wires, antilift.)

APPENDIX.—The tube at the bottom of a balloon, used for inflation and deflation. In the case of a spherical balloon it also serves to increase the "head" of gas, and so to build up an internal pressure sufficient to keep the envelope from being pulled out of shape by the weight of the basket. (Fig. 11.)

APPENDIX MANHOLE.—An appendix in the kite balloon of large diameter and usually rather short. It is used more for access than for inflation or deflation. (Fig. 2.)

APRON.—An open working surface, with a firm floor, in front of a hangar for the storage or handling of airplanes.

ASPECT RATIO.—The ratio of span to mean chord of an airfoil; i. e., the ratio of the square of the span to the area of an airfoil.

ASPECT RATIO OF PROPELLER BLADE.—The ratio of propeller radius to maximum blade width.

ATTITUDE.—The position of an aircraft as determined by the inclination of its axes to some frame of reference. If not otherwise specified, this frame of reference is fixed to the earth and the attitude depends entirely on the position of the aircraft as seen by an observer on the ground.

AUTOMATIC VALVE.—(*See* Valve, automatic.).

AVIATION.—The art of operating heavier-than-air craft.

AXES OF AN AIRCRAFT.—Three fixed lines of reference, usually centroidal and mutually perpendicular. (Part III.) The principal longitudinal axis in the plane of symmetry, usually parallel to the axis of the propeller, is called the longitudinal axis; the axis perpendicular to this in the plane of symmetry is called the normal axis; and the third axis perpendicular to the other two, is called the lateral axis. In mathematical discussions the first of these axes, drawn from front to rear, is called the X axis; the second, drawn upward, the Z axis; and the third, running from right to left, the Y axis.

BALANCED SURFACE.—A control surface which extends on both sides of the axis of the hinge or pivot in such a manner as to reduce the moment of the air forces about the hinge. (Figs. 1, 3, 4, and 5.)

BALLAST.—Any substance, usually sand or water, taken in a balloon or airship and intended to be thrown out, if necessary, for the purpose of reducing the load carried, and thus altering the aerostatic relations. (Figs. 4 and 5.)

BALLONET.—A chamber constructed of fabric within the interior of a balloon or airship for the purpose of controlling the ascent or descent by altering the aerostatic relations and for maintaining the pressure of the gas in the envelope so as to prevent deformation. The ballonet is kept inflated with air at the required pressure, under the control of valves, by a blower or by the action of the wind caught in an air scoop. (Figs. 2, 3, and 5.)

BALLONET DIAPHRAGM.—The fabric partition between the gas and air compartments of the envelope of a nonrigid or semirigid airship or kite balloon.

BALLOON.—An aerostat the form of which is maintained by the pressure of a contained gas lighter than the surrounding air, and which has neither power plant nor means of controlling the direction of flight in a horizontal plane.

BARRAGE.*—A small captive balloon, used to support wires or nets which are intended as a protection against attacks by airplanes.

CAPTIVE.—A balloon restrained from free flight by means of a cable attaching it to the earth.

FREE.—A balloon, usually spherical, whose ascent and descent may be controlled by use of ballast or with a loss of the contained gas, and whose direction of flight is determined by the wind. (Fig. 11.)

KITE.—An elongated form of captive balloon, fitted with lobes to keep it headed into the wind, and usually deriving increased lift due to its axis being inclined to the wind. (Fig. 2.)

NURSE.*—A small balloon made of heavy fabric, employed as a portable means for storing gas.

PILOT.*—A small balloon sent up to show the direction and speed of the wind.

SOUNDING.*—A small balloon sent up without passengers but with recording meteorological instruments.

BALLOON BED.—A mooring place on the ground for a captive balloon.

BALLOON FABRIC.—(*See* Fabric, balloon.)

BANK.—To incline an airplane laterally, i. e., to rotate it about its longitudinal axis. Right bank is to incline the airplane with the right wing down.

Also used as a noun to describe the position of an airplane when its lateral axis is inclined to the horizontal.

BANK, ANGLE OF.—(*See* Angle of roll.)

* Those forms of balloons marked with an asterisk (*) are not, strictly speaking, aircraft.

BAROGRAPH.—An instrument usually the same in principle as an aneroid barometer which makes on a chart a permanent record of the variations of barometric pressure.

BARRAGE BALLOON.—(*See* Balloon.)

BARREL ROLL.—A maneuver in which a complete revolution about the longitudinal axis is made, the horizontal direction of flight being approximately maintained.

BARREL TYPE ENGINE.—(*See* Engine, barrel type.)

BASKET.—The car suspended beneath a balloon, for carrying passengers, ballast, etc., (Figs. 2 and 11.)

BATONET.—A small cylindrical piece of wood, or other material by means of which the rigging of a balloon or airship is attached to a fabric loop on the envelope. (A special form of toggle.)

BAY (BODY PARTS).—The cubical or prismoidal section of a trussing included between two adjacent bulkheads.

BAY (WING PARTS).—The cubical or prismoidal section of a trussing included between two transversely adjacent sets of struts or bulkheads. The first bay of the wing trussing of an airplane is the one adjacent to the plane of symmetry.

BIPLANE.—An airplane with two main supporting surfaces placed one above another. (Fig. 1.)

BIROTARY ENGINE.—(*See* Engine, birotary.)

BLADE BACK.—The cambered side of a propeller blade, corresponding to the upper surface of an airfoil.

BLADE FACE.—The surface of a propeller blade which corresponds to the lower surface of an airfoil. (Sometimes called "Thrust face.")

BLADE WIDTH RATIO.—The ratio of the developed width of a propeller blade at any point to the circumference of the circle whose radius is the distance of that point from the propeller axis.

BOAT SEAPLANE.—(*See* Seaplane.)

BODY.—The fuselage or hull (including cowling and covering) or nacelle (including cowling and covering) and nacelle mounting. (Figs. 1, 4, and 9.)

BONNET.—The appliance, having the form of a hood or parasol, which protects the valve of an airship or balloon against rain. (Also called "Valve cover.") (Figs. 2, 4, and 5.)

BOW CAP.—A cap of metal or fabric used to reinforce the extreme forward ends of the bow stiffeners. Also called nose cap. (Figs. 3, 4, and 5).

BOW STIFFENERS.—Rigid members attached to the bow of a nonrigid or semirigid envelope to reinforce it against the pressure caused by the motion of the airship. Often called nose stiffeners or nose battens. (Figs. 3 and 5.)

BRIDLE.—A sling of cordage which has its ends attached to the suspension band of a captive balloon or airship, or to intermediate points of preceding bridles, and itself supporting from an intermediate point the end of another bridle or a suspension rope.

BULKHEAD.—A transverse structural member of a fuselage or nacelle, continuous around a periphery.

BUOYANCY:

CENTER OF.—The center of gravity of the air displaced by a balloon or airship. (It is approximately the center of gravity of the contained gas.)

GROSS.—The total upward force on an aerostat at rest; the total volume multiplied by the difference of weight density of the air and the contained gas.

There is said to be a condition of positive buoyancy if the gross buoyancy of an aerostat is greater than its weight; but, if the gross buoyancy is less than the weight, the condition is described as one of negative buoyancy.

CABANE.—A pyramidal or prismoidal framework for supporting the wings at the fuselage. Also applied to the system of trussing used to support overhang in a wing. (Figs. 6, 9, and 10.)

CAMBER.—The convexity or rise of the curve of an airfoil section from its chord, usually expressed as the ratio of the maximum departure of the curve from the chord to the length of the chord. "Top camber" refers to the upper surface of an airfoil and "bottom camber" to the lower surface; "mean camber" is the mean of these two; in the case of airfoils having both surfaces convex outward; e. g., portions of a propeller blade, top camber is the maximum distance of the upper surface from the chord, bottom camber is the maximum distance of the lower surface from the chord, camber ratio is the ratio of the maximum thickness of the airfoil to the length of the chord.

CAMBER RATIO, PROPELLER.—(*See* Propeller camber ratio.)

CAPACITY.—The volume, under specified conditions, of the gas containing portion of an aerostat. For balloons and nonrigid airships this is the volume of the envelope completely inflated to normal pressure, with air ballonets empty; for rigid airships, it is the nominal volume of the gas cells at a standard degree of inflation, usually 95 per cent.

CAPTIVE BALLOON.—(*See* Balloon.)

CAR.—That part of the structure of an airship arranged for carrying personnel, cargo, equipment, or power unit. (Figs. 3, 4, and 5.)

CEILING:

ABSOLUTE.—The maximum height above sea level which a given airplane could reach theoretically, assuming standard air conditions.

SERVICE.—The height above sea level, assuming standard air conditions, at which a given airplane ceases to be able to rise at a rate higher than a small specified one (100 feet per minute in the United States and England). This specified rate may be different in different countries.

CEILING, STATIC.—The altitude to which an airship will rise statically after removal of all dischargeable weights.

CELL.—The entire structure of the wings and wing trussing on one side of the fuselage of an airplane, or between fuselages or nacelles, where there are more than one; i. e., two or more bays.

CENTER OF PRESSURE COEFFICIENT.—The ratio of the distance of the center of pressure from the leading edge to the chord length. Its symbol is C_p.

CENTER OF PRESSURE OF AN AIRFOIL SECTION.—The point in the chord of an airfoil section, prolonged if necessary, which is the intersection of the chord and the line of action of the resultant air force. Its abbreviation is *C. P.*

CHORD (OF AN AIRFOIL SECTION).—The line of a straight edge brought into contact with the lower surface of the section at two points; in the case of an airfoil having double convex camber, the straight line joining the leading and trailing edges. (These edges may be defined, for this purpose, as the two points in the section which are farthest apart.) (Fig. 1.) The line joining the leading and trailing edges should be used also in those cases in which the lower surface is convex except for a short flat portion.

The method used for determining the chord should always be explicitly stated for for those sections with regard to which ambiguity seems likely to arise.

CHORD LENGTH.—The length of the projection of the airfoil section on its chord. Its symbol is c.

CHORD, MEAN, OF A COMBINATION OF WINGS.—The ratio

$$\frac{c_1S_1+c_2S_2+c_3S_3+\ \ldots\ \ldots}{S_1+S_2+S_3+\ \ldots\ \ldots}$$

where c_1, c_2, c_3, etc., are the mean chords of the various wings, and S_1, S_2, S_3, etc., are their areas.

CHORD, MEAN, OF A WING.—The quotient obtained by dividing the wing area by the extreme dimension of the wing projection at right angles to the chord.

CHORD WIRES.—Wires joining the vertices of the polygonal frame of the main transverse of the rigid airship. (Fig. 4.)

CLIMB, RATE OF.—(*See* Rate of climb.)

COCKPIT.—The open spaces in which the pilot and passengers are accommodated. (Fig. 1.) When the cockpit is completely housed in it is called a cabin.

CONCENTRATION RING (LOAD RING):

AIRSHIP.—A ring to which several rigging lines are brought from the envelope and from which one or more lines also lead to the car.

FREE BALLOON.—A ring to which are attached the ropes suspending the basket and to which the net is also secured. (Fig. 11.)

CONSUMPTION PER B. HP. HOUR.—The quantity of fuel or oil consumed per hour by an engine divided by the uncorrected brake horsepower developed, unless specifically stated otherwise.

CONTROL COLUMN, OR YOKE.—A control lever with a rotatable wheel mounted at its upper end. (*See* Control stick.) Pitching is controlled by fore-and-aft movement of the column; rolling, by rotation of the wheel. "Wheel (or Dep) control" is that type of control in which such a column or yoke is used.

CONTROL STICK.—The vertical lever by means of which the longitudinal and lateral controls of an airplane are operated. Pitching is controlled by a fore-and-aft movement of the stick, rolling by a side-to-side movement. "Stick control" is that type of control in which such a stick is used. (Fig. 1.)

CONTROL SURFACE.—A movable surface designed to be rotated or otherwise moved by the pilot in order to change the attitude of the airplane or airship.

CONTROLS.—A general term applying to the means provided to enable the pilot to control the speed, direction of flight, attitude, and power of an aircraft.

CONTROLLABILITY.—The quality in an airplane which makes it possible for the pilot to change its attitude easily and with the exertion of little force.

CORD GROMMET.—A small ring of cord.

CORD NETTING.—(*See* Net.)

COWLING.—A removable covering which extends over or around the engine, and sometimes over a portion of the fuselage or nacelle as well. (Fig. 1.)

CRITICAL ANGLE.—(*See* Angle, critical.)

CRITICAL SPEED.—(*See* Speed, critical.)

CROSS-COUNTRY FLIGHT.—A flight starting at one landing field and terminating at another not within gliding distance of the former.

CROSS-WIND FORCE.—The component perpendicular to the lift and to the drag of the total air force on an aircraft or airfoil. Its symbol is C; and its absolute coefficient C_c is defined by

$$C_c = \frac{C}{qS}$$

CROW'S-FOOT.—A system of diverging short ropes for distributing the pull of a single rope.

D RING.—A ring having, as the name implies, the shape of a capital D, to which rope suspensions are attached.

DAMPED HARMONIC MOTION.—Motion defined by the differential equation

$$a\frac{d^2s}{dt^2} + b\frac{ds}{dt} + c\,s = 0,$$

in which

a is the mass (or moment of inertia),
s is the displacement,
b is the coefficient of damping force (or moment),
c is the coefficient of force (or moment) of restitution.

The ratio $\frac{b}{a}$ is called the damping coefficient.

The solution of the equation is

$$s = Ae^{-\lambda t} \sin pt,$$

in which

$$\lambda = -\frac{1}{2}\frac{b}{a}, \quad p = \sqrt{\frac{c}{a} - \lambda^2}$$

A is the amplitude at the instant from which time (t) is counted.

DAMPING FACTOR.—The term $e^{-\lambda t}$ in the equation of damped harmonic motion $s = Ae^{-\lambda t} \sin pt$.

DANGER CONES.—Pendents on the wire cable of a captive balloon, usually hollow cones of light cloth, to warn aircraft of its presence.

DEAD LOAD.—(*See* Load.)

DECALAGE.—The acute angle between the wing-chords of a biplane or multiplane. (Fig. 1.)

DEFLATION.—The act of removing gas from an aerostat.

DEFLATION SLEEVE.—A sleeve or appendix fitted on the lower lobe of a kite balloon and used to permit the rapid escape of the air in the lobes when the balloon is hauled down. (Fig. 2.)

DEP CONTROL.—(*See* Control column.)

DIHEDRAL ANGLE.—(*See* Angle, dihedral.) (Fig. 1.)

DISCHARGEABLE WEIGHT.—The excess of the gross buoyancy of an aerostat over the sum of the dead load and the weight of the crew and such items of equipment as are essential to enable an airship to fly and land safely.

DIVE.—A steep glide or flight.

DIVERGENCE.—A motion in which, after a disturbance, the body departs continuously, without oscillations, from its original state of motion.

DOPE, AIRPLANE.—The liquid material applied to the cloth surface of airplane members to increase strength, to produce tautness, and to act as a filler which maintains air-tightness.

DOPE, AIRSHIP.—The liquid material applied to airship fabric to increase gas-tightness. In contrast with airplane dope, it does not cause shrinking.

DOWNWASH ANGLE.—(*See* Angle, downwash.)

DRAG.—The component parallel to the relative wind of the total air force on an aircraft or airfoil. Its symbol is D.

The "Absolute drag coefficient" is C_D as defined by the equation $C_D = \frac{D}{qS}$ in which D is the drag, q is the impact pressure $\left(=\frac{1}{2}\rho V^2\right)$ and S is the effective area of the surface upon which the air force acts.

In the case of an airplane, that part of the drag due to the wings is called "wing drag"; that due to the rest of the airplane is called "structural drag" or "parasite resistance."

DRAG, INDUCED.—That portion of the drag which would be experienced in a nonviscous fluid.

DRAG ROPE.—A long rope attached by one end to a toggle in the concentration ring of a free balloon, and which can be hung overboard so as to act as a brake and a variable ballast in making a landing. On airships a similar rope is used as a grab or mooring line by the landing party, and is sometimes called the grab line. Same as Trail rope. (Figs. 2, 3, 4, and 5.)

DRAG STRUT.—A fore-and-aft compression member of the internal bracing system of a wing. (Figs. 1 and 15.)

DRAG WIRES.—(*See* Wires, drag.)

DRIFT.—The lateral velocity of an aircraft, due to air currents or other causes.

DRIFT ANGLE.—(*See* Angle, drift.)

DRIFT METER.—An instrument for the measurement of the angular deviation of an aircraft from a set course.

DRIP BAND.—A strip of fabric attached by one edge to the envelope of an aerostat so that rain runs off its free edge instead of dripping into the basket or car. The drip band also assists in keeping the suspension ropes dry and nonconducting.

DRY WEIGHT (ENGINE).—The weight of an engine including carburetors, propeller hub assembly, and ignition system complete, but excluding exhaust manifolds, oil, and water.

DYNAMIC FACTOR.—The ratio between the load carried by any part of an aircraft when accelerating or when otherwise subjected to abnormal conditions and the load carried in normal flight, the conditions of such loadings being specified.

DYNAMIC LOAD.—Any load due to accelerations of an aircraft, and therefore proportional to its mass.

DYNAMIC (OR IMPACT) PRESSURE.—The product $1/2\ \rho\ V^2$ where ρ is the density of the air and V is the relative speed of the air. It is the quantity measured by most airspeed instruments. Its symbol is q.

EFFECTIVE HELIX ANGLE.—(*See* Angle, effective helix.)

ELEVATOR.—A movable auxiliary surface, usually hinged to the stabilizer, the function of which is to impress a pitching moment on the aircraft. (Figs. 1, 3, 4, and 5.)

ELEVATOR ANGLE.—(*See* Angle, elevator.)

EMPENNAGE.—(*See* Tail group.)

ENDURANCE.—The maximum length of time an aircraft can remain in the air at a given speed at a stated altitude. Full speed and sea level are implied, when the word is used without specifications.

ENGINE, BARREL-TYPE.—An engine having its cylinders arranged equidistant from and parallel to the main shaft.

ENGINE, BIROTARY.—An engine having its cylinders arranged in any manner around the crank-shaft, as in a radial or barrel-type engine, the cylinder unit and the crank-shaft unit rotating in opposite directions.

ENGINE, FAN-TYPE.—An engine having its cylinders arranged in a radial direction but occupying less than the full circle.

ENGINE, LEFT-HAND.—An engine having a propeller shaft which, to an observer facing the propeller hub, rotates in a clockwise direction.

ENGINE, RADIAL.—An engine having stationary cylinders arranged radially around a common crank-shaft.

ENGINE, RIGHT-HAND.—An engine having a propeller shaft which, to an observer facing the propeller hub, rotates in a counter-clockwise direction.

ENGINE, ROTARY.—An engine having its cylinders arranged in any manner around the crank-shaft as in a barrel or radial engine, the cylinder units revolving around the crank-shaft, which is stationary.

ENGINE, SUPERCHARGED.—An engine with equipment which enables a greater weight of charge to be furnished than would normally be induced.

ENGINE, VARIABLE COMPRESSION.—An engine provided with mechanical means for varying the volume of the compression space.

ENTERING EDGE.—(*See* Leading edge.)

ENVELOPE.—The outside gas-containing fabric of a nonrigid or semirigid airship or balloon. It may be divided by diaphragms into separate gas compartments or cells, and may also contain internal air cells or ballonets. (Figs. 3, 5, and 11.)

FABRIC, BALLOON.—The finished material, usually rubberized, of which balloon or airship envelopes are made.

BIASED.—Plied fabric in which the threads of the plies are at an angle to each other.

PARALLEL.—Plied fabric in which the threads of the plies are parallel to each other.

FACTOR, DYNAMIC.—(*See* Dynamic factor.)

FACTOR OF SAFETY.—(*See* Safety, factor of.)

FAIRING.—An auxiliary member or structure whose primary function is to reduce head resistance or drag of the part to which it is fitted, and which does not in general bear any stress.

FAN-TYPE ENGINE.—(*See* Engine, fan-type.)

FIELD HANDLING FRAME.—A portable frame, usually made of tubing and braced with wires, which is attached to the rigid airship when it is on the ground, and is intended to afford a grasp to more men than could get on the handling rails of the cars. These frames are rarely carried when in flight. (Fig. 4.)

FILLING SLEEVE.—(*See* Inflation sleeve.)

FINS.—Small fixed surfaces, attached to different parts of aircraft, parallel to the longitudinal axis, in order to secure stability; for example, tail fins, skid fins, etc. Fins are in the great majority of cases substantially vertical, and are sometimes adjustable. (Figs. 1, 3, 4, 5, 6, 9, 10 and 14.)

FIRE WALL.—A fire-resistant transverse bulkhead, so set as to isolate the engine compartment from the other parts of the structure, and thus to reduce the risk from fire in the engine compartment. (Fig. 1.)

FITTING.—A generic term for any small metal part used in the structure of an airplane or airship.

FLIGHT PATH.—The path of the center of gravity of an aircraft with reference to the earth.

FLOAT (or PONTOON).—A completely inclosed water-tight structure attached to an aircraft in order to furnish it buoyancy when in contact with the surface of the water. In float seaplanes the crew is carried in a fuselage or nacelle separate from the float. (Fig. 10.)

FLOAT SEAPLANE.—(*See* Seaplane.)

FLOTATION GEAR.—An emergency gear attached to a land plane to permit alighting on the water and to provide buoyancy when resting on the surface of the water.

FLYING BOAT.—(*See* Seaplane.)

FREE BALLOON.—(*See* Balloon.)

FULL LOAD.—(*See* Load.)

FUSELAGE.—The elongated structure, of approximately streamline form, to which are attached the wings and tail unit of an airplane. In general, it contains the power plant, passengers, cargo, etc. (Fig. 1.)

FUSELAGE, LENGTH OF.—The distance from the nose of the fuselage (including the engine bed and radiator, if present) to the after end of the fuselage, not including the control and stabilizing surfaces.

FUSELAGE, MONOCOQUE.—A type of fuselage construction wherein the structure consists of a thin shell of wood or metal, supported by bulkheads. The shell is designed to carry all stresses arising in the fuselage.

FUSELAGE SEMIMONOCOQUE.—A type of fuselage construction wherein the structure consists of a thin shell of wood or metal supported by a framework of bulkheads and longerons. The latter are designed to take stresses in bending, while the shell is designed to take the shearing stresses.

FUSELAGE, VENEER.—A type of fuselage which is built up by covering a framework of longerons and bulkheads with a plywood skin.

GAP.—The distance between the planes of the chords of the upper and lower wings of a biplane, measured along a line perpendicular to the chord of the upper wing at any designated point of its landing edge. (Fig. 1.) Its symbol is G.

GAS CONTAINER.—The bag or cell that contains the hydrogen or aerostatic gas. (Figs. 4 and 5.)

GASSING.—The operation of replenishing the balloon with fresh gas to increase its purity or to make up for loss of gas due to leakage.

GLAND.—A short tube fitted to an envelope or gas bag in such a manner that a rope or line may pass through without leakage of gas or air. (Figs. 2 and 5.)

GLIDE.—To descend at a normal angle of attack without engine power sufficient for level flight, the propeller thrust being replaced by a component of gravity along the line of flight. Also used as a noun.

GLIDER.—A form of aircraft similar to an airplane, but without a power plant.

GLIDING ANGLE.—(*See* Angle, gliding.)

GORE.—The portion of the envelope of a balloon or airship included between two adjacent meridian seams.

GROUND ANGLE.—(*See* Angle, landing.)

GROUND CLOTH.—Canvas placed on the ground to protect an aerostat.

GROUND-SPEED.—The horizontal component of the velocity of an aircraft relative to the earth.

HANDLING FRAME, FIELD.—(*See* Field handling frame.)

HANDLING LINES.—Lines attached along the sides of an airship for use in handling near and on the ground. (Figs. 2, 3, 4 and 5.)

HANGAR.—A shelter for housing aircraft.

HELICOPTER.—A form of aircraft heavier than air whose chief support in the air is derived from the vertical thrust of propellers.

HOG.—A distortion of an airship in which the longitudinal axis becomes convex upward, or both ends droop.

HORN.—The operating lever of a control surface of an aircraft, e. g., aileron horn, rudder horn, elevator horn. (Figs. 1, 3, and 4.)

HORSEPOWER OF AN ENGINE, MAXIMUM.—The maximum horsepower which can be safely maintained for periods not less than five minutes.

HORSEPOWER OF AN ENGINE, NORMAL.—The highest horsepower which can be safely maintained for long periods.

HULL (AIRSHIP).—The main structure of a rigid airship, consisting of a covered elongated framework which incloses the gas bags and supports the cars and equipment. (Fig. 4.)

HULL (SEAPLANE).—The portion of a boat seaplane which furnishes buoyancy when in contact with the surface of the water. The main supporting surfaces are attached to it and it contains accommodations for the crew and passengers. (Fig. 9.)

IMPACT PRESSURE.—(*See* Dynamic pressure.)

INCIDENCE, ANGLE OF.—(*See* Angle of wing setting.)

INCIDENCE WIRES.—(*See* Wires, stagger.)

INCLINOMETER:

ABSOLUTE.—An instrument giving the attitude of an aircraft with reference to the vertical.

RELATIVE.—An instrument giving the attitude of an aircraft with reference to apparent gravity, i. e., to the resultant of the acceleration of the aircraft and gravity. Such instruments are sometimes incorrectly referred to as banking indicators.

INDICATORS.—(*See* Airspeed indicator; Turn indicator.)

INDRAFT (INFLOW).—The flow of air from in front of the propeller into the blades.

INDUCED DRAG.—(*See* Drag.)

INFLATION.—The act of filling a balloon or airship with gas in preparation for flight.

INFLATION MANIFOLD.—A metal connection with numerous inlets which permits the passage of gas at one time from a number of sources—either cylinders or gas holders—to the main inflation tube.

INFLATION SLEEVE (or FILLING SLEEVE).—A tubular fabric attachment to an envelope or gas bag, serving as a lead for the inflating hose. (Figs. 3 and 5.)

INFLOW.—(*See* Indraft.)

INSPECTION WINDOW.—A small transparent window fitted in the envelope of a balloon or airship, or in the wing of an airplane, to allow inspection of the interior. (Figs. 1 and 3.)

JACKSTAY.—A longitudinal rigging provided to maintain the correct distance between the heads of various rigging parts on an aerostat.

KEEL.—A member or assembly of members which contributes longitudinal strength to an airship of the rigid or semirigid type. In either case the keel is usually an elaborately trussed girder and may be inclosed within the envelope or may project below the regular cross-sectional form of the envelope. (Figs. 4 and 5.)

ARTICULATED.—A keel made up of a series of members connected at their ends by hinged joints. (Fig. 5.)

KING POST.—The main compression member of a trussing system applied to support a single member subject to bending. (Figs. 4 and 6.)

KITE.—A structure heavier than air, without other propelling means than the towline pull, the support being derived from the wind moving past its surfaces.

KITE BALLOON.—(*See* Balloon.)

KYMOGRAPH.—An instrument for recording the rotary motions of an airplane in flight. In general its action depends upon a gyroscope or it makes use of a beam of sunlight focused on a moving film.

LAMINATED WOOD.—A product formed by gluing or otherwise fastening together individual wood planks or laminations with the grain substantially parallel.

LANDING ANGLE.—(*See* Angle, landing.)

LANDING FIELD.—A field of such a size and nature as to permit of airplanes landing and taking off in safety.

LANDING GEAR.—The understructure of an aircraft designed to carry the load when in contact with the land or water. There are four types—boat type, float type, skid type, and wheel type. (Figs. 1, 6, 9, 10, and 14.)

LANDING T—A white mark shaped like the capital letter T laid out on the landing area of a landing field to indicate the direction of the wind for guidance in landing and take-off of airplanes.

LANDPLANE.—An airplane designed to rise from and alight on the land. (Figs. 1, 6 and 14.)

LEADING EDGE.—The foremost edge of an airfoil or propeller blade. (Also called "Entering edge.") (Fig. 1.)

LEAK DETECTOR.—An instrument which detects the presence of hydrogen and other light gases in the air, and which can be adapted to find leaks in a container inflated with such a gas.

LEEWAY.—The lateral velocity of an aircraft caused by horizontal air currents.

LEFT-HAND ENGINE.—(*See* Engine, left-hand.)

LENGTH OF FUSELAGE.—(*See* Fuselage, length of.)

LENGTH, OVER-ALL.—(*See* Over-all length.)

LIFT.—The component perpendicular to the relative wind and in the plane of symmetry of the total air force on an aircraft or airfoil. It must be specified whether this applies to a complete aircraft or to parts thereof. (In the case of an airship this is often called "Dynamic lift.") Its symbol is L.

The "Absolute lift coefficient" is C_L as defined by the equation $C_L = \frac{L}{qS}$, in which L is the lift, q is the impact pressure $\left(= \frac{1}{2}\rho V^2\right)$, and S is the effective area of the surface upon which the air force acts.

LIFT WIRES.—(*See* Wires, lift.)

LOAD:

DEAD.—The structure, power plant, and fixed equipment of an aircraft. Included in this fixed equipment are the water in the radiator and cooling system, all essential instruments and furnishings, fixed electric wiring for lighting, heating, etc., and also, in the case of an aerostat, the amount of ballast which must be carried to assist in making a safe landing.

FULL.—Dead load plus useful load.

PAY.—That part of the useful load from which revenue is derived, viz, passengers and freight.

USEFUL.—The crew and passengers, oil and fuel, ballast, ordnance and portable equipment.

LOAD, DYNAMIC.—(*See* Dynamic load.)

LOAD FACTOR.—The ratio of the breaking load of a member to the load under conditions of horizontal steady rectilinear flight.

LOAD RING.—(*See* Concentration ring.)

LOBES.—Air inflated bags at the stern of a kite balloon designed to give it directional stability. They may act as fins or stabilizers. (Fig. 2.)

LOGARITHMIC DECREMENT.—The product λT where λ is the coefficient appearing in the damping factor of damped harmonic motion and T is the period of the motion $\left(\text{equal to } \frac{2\pi}{p}\right)$. (*See* Damped harmonic motion.)

LONGERON.—A fore-and-aft member of the framing of an airplane fuselage or nacelle, usually continuous across a number of points of support. (Fig. 1.)

LOOP.—A maneuver in which the airplane describes an approximately circular path in the plane of symmetry, the lateral axis remaining horizontal and the upper side of the airplane remaining on the inside of the circle.

MANEUVERABILITY.—That quality in an airplane which makes it possible for the pilot to change its attitude rapidly.

MANOMETER PRESSURE.—The excess of pressure inside the envelope of an aerostat over the atmospheric pressure. In the case of an airship, the point of reference for the excess of pressure is the bottom of the gas cell.

MINIMUM SPEED.—(*See* Speed, minimum.)

MONOCOQUE FUSELAGE.—(*See* Fuselage, monocoque.)

MONOPLANE.—An airplane which has but one main supporting surface, sometimes divided into two parts by the fuselage. (Fig. 6.)

MOORING BAND.—A band of tape or webbing over the top of a kite balloon to which are attached the mooring ropes. It forms part of a mooring harness. (Fig. 2.)

MOORING CONE.—The grooved conical member which engages with a hollow cone at the top of the mooring mast and provides the coupling between the rigid airship and the mooring mast. (Fig. 4.)

MOORING CONE OUTRIGGER.—The member, usually tubular, which supports the mooring cone at the bow of the rigid airship. (Fig. 4.)

MOORING HARNESS.—A system of bands of tape over the top of a balloon to which are attached the mooring ropes.

MOORING LINE.—A line attached near the bow of an airship by which it may be secured to the ground or to a mooring mast. (Figs. 3, 4, and 5.)

MOORING LOOPS.—A system of cordage loops on the envelope of a kite balloon for suspending sand bags.

MOORING MAST.—A mast or tower at the top of which there is mounted a fitting so that the bow of an airship may be secured. It is usually provided with a ladder or staircase and a platform at the top so that crew and passengers may enter or leave the airship, and also with piping for the supply of fuel, gas, and water.

MOORING ROPES.—Lines attached to the mooring harness of a balloon for use in securing it to the ground. (Fig. 2.)

MULTIPLANE.—An airplane with two or more main supporting surfaces placed one above another.

NACELLE.—An inclosed shelter for passengers or for a power plant. A nacelle is usually shorter than a fuselage, and does not carry the tail unit.

NET:

FREE BALLOON.—A rigging made of ropes and twine shaped to the upper surface of the envelope, which supports the weight of the basket, etc., distributing the load over the entire upper surface of the envelope. (Fig. 11.)

INFLATION.—A rectangular net of cordage used to restrain the envelope of a kite balloon or airship during inflation and before the car is attached.

RIGID BALLOON.—A netting of cord, usually ramie, of small mesh which receives the first lift from the gas cells and imparts this lift to a wire netting of coarser mesh, both being fitted between the horizontals. (Fig. 4.) It may be compared to the net of a free balloon.

NONRIGID AIRSHIP.—(*See* Airship.)

NOSE CAP.—(*See* Bow cap.)

NOSE HEAVY.—The condition of an aircraft in which, in normal flight, the nose tends to drop if the longitudinal control is released; i. e., the condition in which the pilot has to exert a pull on the control stick or column to maintain the given altitude.

NURSE BALLOON.—(*See* Balloon.)

NURSING TUBE.—An elongated appendix or inflation sleeve of the kite balloon which is brought down to the basket and fitted with a quick connection coupling. This coupling can be attached to a similar piece on a tube on the deck of the ship and gas may be sent into the balloon within a few minutes after it has reached the deck. (Fig. 2.)

ORNITHOPTER.—A form of aircraft heavier than air deriving its chief support and propelling force from flapping wings.

OSCILLATION, PHUGOID.—A long-period oscillation characteristic of the disturbed longitudinal motion of an airplane. This is referred to when it is said that an airplane "hunts."

OSCILLATION, STABLE.—An oscillation whose amplitude decreases continuously.

OSCILLATION, UNSTABLE.—An oscillation whose amplitude increases continuously till the whole motion is changed.

OUTER COVER (Airship).—The outside covering of the hull of a rigid airship, usually of fabric. (Fig. 4.)

OVER-ALL LENGTH.—The distance from the extreme front to the extreme rear of an aircraft, including the propeller and the tail unit.

OVERHANG.—One-half the difference in the span of any two main supporting surfaces of an airplane. The overhang is positive when the upper of the two main supporting surfaces has the larger span. (Fig. 1.)

PANCAKE.—To "level off" an airplane at a greater altitude than in a normal landing, causing it to stall and descend with the wings at a very large angle of attack and approximately without bank, on a steeply inclined path.

PANEL (AEROSTAT).—The unit piece of fabric of which the envelope of an aerostat is made.

PANEL (WING PARTS).—A separately constructed portion of a wing which is attached to the remainder by bolts and fittings.

PARACHUTE.—An apparatus used to retard the descent of a falling body by offering resistance to its motion through the air. It is usually made of light fabric, so that it may be packed in a small space in such a manner that it will readily unfold when released with a falling body attached.

(Strictly speaking, not an aircraft.)

PARASITE RESISTANCE.—(*See* Drag.)

PATCH.—A strengthened or reinforced flap of fabric, which is cemented to the envelope and forms an anchor by which some portion of the structure is attached to the envelope. (Fig. 12.)

PAY LOAD.—(*See* Load.)

PERFORMANCE CHARACTERISTICS (AIRPLANE):

(*a*) Maximum and minimum speed at various altitudes.
(*b*) Rates of climb at various altitudes.
(*c*) Time to climb to various altitudes.
(*d*) The service ceiling.
(*e*) The absolute ceiling.
(*f*) The landing speed or minimum speed.
(*g*) Power plant characteristics corresponding to above.

PERFORMANCE CHARACTERISTICS (AIRSHIP).—In general:

(*a*) Maximum speed at various altitudes.
(*b*) Maximum altitude attainable with definite weight relations and ballonet volume (if fitted).
(*c*) Endurance at full and half power.
(*d*) Static ceiling.
(*e*) Dynamic lift under specified conditions.

PERFORMANCE TESTING.—The process of determining performance characteristics.

PERIOD.—The time taken for a complete oscillation.

PERMEABILITY.—The measure of the rate of diffusion of gas through intact balloon fabric; usually expressed in liters per square meter of fabric per 24 hours, under standard conditions of pressure and temperature.

PHUGOID OSCILLATION.—(*See* Oscillation, phugoid.)

PILOT.—An operator of aircraft. This term is applied regardless of the sex of the operator.

PILOT BALLOON.—(*See* Balloon.)

PITCH, ANGLE OF.—(*See* Angle of pitch.)

PITCH OF A PROPELLER:

(*a*) PITCH, AERODYNAMIC.—The distance a propeller would have to advance in one revolution in order that the torque might be zero. Its symbol is p_a.
(*b*) PITCH, EFFECTIVE.—The distance an aircraft advances along its flight path for one revolution of the propeller. Its symbol is p_e.
(*c*) PITCH, GEOMETRICAL.—The distance an element of a propeller would advance in one revolution if it were moving along a helix of slope equal to its blade angle.
(*d*) PITCH, MEAN GOEMETRICAL.—The mean of the geometrical pitches of the several elements. Its symbol is p_g.
(*e*) PITCH, STANDARD.—The geometrical pitch taken at two-thirds of the radius. (Also called nominal pitch.) Its symbol is p_s.
(*f*) PITCH, VIRTUAL.—The distance a propeller would have to advance in one revolution in order that there might be no thrust. (Also called experimental mean pitch.) Its symbol is p_v.

PITCH RATIO.—The ratio of the pitch to the diameter.

PITCH SPEED.—The product of the mean geometrical pitch by the number of revolutions of the propeller in unit time; i. e., the speed the aircraft would make if there were no slip.

PITOT TUBE.—A cylindrical tube with an open end, designed to be used with the open end pointing upstream to detect the impact pressure of a fluid stream. When used on aircraft it is associated either with a closed coaxial tube surrounding it, or with a closed tube placed near it and parallel to it. The associated tube has perforations in its side, and the air inside is subjected to static pressure, as distinct from impact pressure. The speed of the fluid can be determined from the difference between the impact pressure and the static pressure, as read by a suitable gauge. (Fig. 7.)

PLYWOOD.—A product formed by gluing together two or more layers of veneer.

PONTOON.—(*See* Float.)

POWER LOADING.—The gross weight of an airplane fully loaded divided by the normal brake horsepower of the engine computed for air of standard density, unless otherwise stated.

PRESSURE, DYNAMIC.—(*See* Dynamic pressure.)

PRESSURE, MANOMETER.—(*See* Manometer pressure.)

PRESSURE, NOZZLE.—The apparatus which, in combination with a gauge, is used to measure the pressure due to speed through the air. It may be a Pitot or a Venturi tube, or a combination of the two. Pressure nozzles of various types are also used in yawmeters and other instruments.

PRESSURE TUBE.—A tube fitted to the side of an envelope or gas bag, to which a pressure gauge may be attached.

PROFILE.—(*See* Airfoil section.)

PROOFING.—Material incorporated in the fabric of an aerostat at the time of manufacture, to increase its resistance to the weather and to prevent the passage of gas.

PROPELLER AREA, PROJECTED.—The total disk area less that portion extending 0.2 of the radius from the axis of the shaft.

PROPELLER BLADE.—(*See* Blade face; Blade back; Blade width ratio.) (Fig. 1.)

PROPELLER BLADE, ANGLE OF.—(*See* Angle of propeller blade.)

PROPELLER BLADE AREA.—The area of the blade face, exclusive of the boss and the root; i. e., of a portion which is usually taken as extending 0.2 of the radius from the axis of the shaft.

PROPELLER BLADE, ASPECT RATIO OF.—(*See* Aspect ratio of propeller blade.)

PROPELLER BOSS.—The central portion of a propeller in which the hub is mounted. (Fig. 1.)

PROPELLER CAMBER RATIO.—The ratio of the maximum thickness of a propeller section to its chord.

PROPELLER DISK AREA, TOTAL.—The total area swept by a propeller; i. e., the area of a circle having a diameter equal to the propeller diameter.

PROPELLER EFFICIENCY.—The ratio of thrust power to power output of a propeller. Its symbol is η.

PROPELLER HUB.—The metal fitting inserted in a wooden propeller for the purpose of mounting it on the engine shaft. (Fig. 1.)

PROPELLER INTERFERENCE.—The amount by which the torque and thrust of a propeller are changed by the modification of the air flow in the slipstream produced by bodies placed near the propeller, such as the engine, radiator, etc.

PROPELLER LOAD CURVE.—A curve representing engine power necessary to drive any given propeller at various speeds. The power required varies directly as the cube of the speed in R. P. M., provided the ratio $\frac{V}{ND}$ remains constant.

PROPELLER PITCH.—(*See* Pitch of a propeller.)

PROPELLER, PUSHER.—A propeller which is placed at the rear end of its shaft and pushes against the thrust bearing.

PROPELLER RAKE.—The angle which the line joining the centroids of the sections of a propeller blade makes at the axis, with a plane perpendicular to the axis.

PROPELLER ROOT.—That part of the propeller blade near the boss.

PROPELLER SECTION.—A cross-section of a propeller blade made at any point by a plane perpendicular to the blade axis.

PROPELLER THRUST.—The component parallel to the propeller axis of the total air force on the propeller. Its symbol is T.

PROPELLER TORQUE.—The moment produced on the propeller by the engine shaft. Its symbol is Q.

PROPELLER, TRACTOR.—A propellor which is placed at the forward end of its shaft and pulls on the thrust bearing.

PROPELLER WIDTH RATIO, TOTAL.—The product of blade width ratio at the point of maximum blade width by number of blades.

PURITY (OF HYDROGEN OR OTHER AEROSTATIC GAS).—The ratio of the pressure of the hydrogen (or other aerostatic gas) in the container to the total pressure due to all the contained gases.

PUSHER AIRPLANE.—An airplane with the propeller or propellers in the rear of the main supporting surfaces. (Figs. 9 and 14.)

PUSHER PROPELLER.—(*See* Propeller, pusher).

QUADRUPLANE.—An airplane with four main supporting surfaces, placed one above another.

RACE ROTATION.—The rotation of the air influenced by a propeller. This rotation is much more marked in the slipstream than in front of the propeller.

RADIAL ENGINE.—(*See* Engine, radial).

RAKE.—The cutting away of the wing tip at an angle so that the plan form of the main supporting surfaces is trapezoidal. The amount of rake is measured by the acute angle between the straight portion of the wing-tip outline and the plane of symmetry. The rake is positive when the trailing edge is longer than the leading edge. (Fig. 1.)

RAKE, PROPELLER.—(*See* Propeller rake.)

RATE OF CLIMB.—The vertical component of the airspeed of an aircraft; i. e., its vertical velocity with reference to the air.

RATE-OF-CLIMB METER.—An instrument to measure the vertical component of the velocity of an aircraft. Most rate-of-climb meters depend on the rate of change of the atmospheric pressure.

RELATIVE WIND.—The motion of the air with reference to a body; i. e., its motions as observed by a man at rest on the body. The direction and velocity of the relative wind, therefore, are found by adding two vectors, one being the velocity of the air with reference to the earth, the other being equal and opposite to the velocity of the body with reference to the earth.

RESISTANCE DERIVATIVES.—Quantities expressing the variation of the forces and moments on aircraft due to disturbance of steady motion. They form the experimental basis of the theory of stability, and from them the periods and damping factors of aircraft can be calculated. In the general case there are 18 translatory and 18 rotary derivatives.

ROTARY.—Resistance derivatives expressing the variation of moments and forces due to small changes in the rotational velocities of the aircraft.

TRANSLATORY.—Resistance derivatives expressing the variation of moments and forces due to small increases in the translational velocities of the aircraft.

LONGITUDINAL.—Resistance derivatives expressing the variation of moments and forces due to small increases in the longitudinal, normal, and pitching velocities.

LATERAL.—Resistance derivatives expressing the variation of moments and forces due to small increases in the lateral, yawing, and rolling velocities.

RESTORING MOMENT.—(*See* Righting moment.)

REVERSE TURN.—A rapid maneuver to reverse the direction of flight of an airplane, made by a half loop and half roll.

REVOLUTIONS, MAXIMUM.—The maximum number of revolutions per minute that may be maintained for periods not less than five minutes.

REVOLUTIONS, NORMAL.—The highest number of revolutions per minute that may be maintained for long periods.

REYNOLDS NUMBER.—A name given the fraction $\rho\frac{Vl}{\mu}$ in which

ρ is the density of the air;
V is the relative velocity of the air;
l is a linear dimension of the body;
μ is the coefficient of viscosity of the air.

RIB.—(*See* Wing rib.)

RIGGER.—One who is employed in assembling and aligning aircraft.

RIGGING.—The assembling, adjusting, and aligning of the parts of an airplane, or the attachment and adjustment of the car, rudders, valves, controls, etc., of an airship.

RIGHT-HAND ENGINE.—(*See* Engine, right-hand.)

RIGHTING MOMENT (or RESTORING MOMENT).—A moment which tends to restore an aircraft to its previous attitude after any small rotational displacement.

RIGID AIRSHIP.—(*See* Airship.)

RIP CORD.—The rope running from the rip panel to the car or basket, the pulling of which tears off or rips the rip panel and causes immediate deflation.

RIP PANEL.—A strip in the upper part of the envelope of a balloon or semirigid or nonrigid airship which is torn off or ripped when immediate deflation is desired. (Figs. 2 and 3.)

ROLL, ANGLE OF.—(*See* Angle of roll.)

ROTARY ENGINE.—(*See* Engine, rotary.)

RUDDER.—A movable auxiliary surface, usually attached at the rear end of an aircraft, the function of which is to impress a yawing moment upon the aircraft. (Figs. 1, 3, 4, and 5.)

RUDDER ANGLE.—(*See* Angle, rudder).

RUDDER BAR.—The foot bar by means of which the control cables leading to the rudder are operated. (Fig. 1.)

RUDDER TORQUE.—The twisting moment exerted by the rudder on the fuselage. The product of the rudder area by the distance from its center of area to the axis of the fuselage may be used as a relative measure of rudder torque.

RUNWAY (HANGAR FOR SEAPLANES).—A firm inclined surface leading from the entrance of a hangar for seaplanes into the water. Seaplanes are beached on this surface and drawn up it for storage in the hangar.

RUNWAY (LANDING FIELD).—A smooth and elongated area on a landing field along which the airplanes alight and take off. Also, a temporary surface erected on a landing field when it is muddy or soft to facilitate the take-off and alighting of airplanes.

SAFETY, FACTOR OF.—The ratio of the breaking load of a member to the maximum load which can occur in actual use under specific conditions.

SAFETY LOOP.—A loop formed immediately outside the fitting, through which the rip cord emerges from the botton of an aerostat. Before the rip panel can be opened by the rip cord, the fastening of this safety loop must be torn off by a strong pull on the cord.

SAG.—A distortion of an airship in which the longitudinal axis becomes concave upward, or both ends rise.

SEAPLANE.—An airplane designed to rise from and alight on the water.

BOAT SEAPLANE (or FLYING BOAT).—A form of seaplane having for its central portion a hull or boat which provides flotation in addition to serving as a fuselage. It is often provided with auxiliary floats or pontoons for lateral support on the water. (Fig. 9.)

FLOAT SEAPLANE.—A form of seaplane fitted with one or more floats or pontoons instead of a hull. (Fig. 10.)

SEMIRIGID AIRSHIP.—(*See* Airship.)

SHEATHING.—(*See* Tipping.)

SHED.—A shelter for housing airships.

SHIPPLANE.—A landplane designed to rise from and alight on the deck of a ship.

SHOCK ABSORBER.—A spring or elastic member, designed to prevent the imposition of large accelerations on the structure of the airplane when landing or taking off. Shock absorbers are usually interposed between the wheels, floats, or tail skid, and the remainder of the airplane to secure resiliency in landing and taxying. (Fig. 1.)

SIDE SLIPPING.—Flight in which the lateral axis is inclined and the airplane has a component of velocity in the direction of its lower end. When it occurs in connection with a turn it is the opposite of skidding (q. v.).

SKID FINS.—Fore-and-aft vertical surfaces, usually placed above the upper wings, designed to provide vertical keel surface and so to increase lateral stability. (Figs. 9 and 10.)

SKIDDING.—Sliding sidewise away from the center of curvature when turning. It is usually caused by banking insufficiently, and is the opposite of side slipping (q. v.).

SKIDS.—Runners used as members of the landing gear and designed to aid the aircraft in landing or taxying.

TAIL SKID.—A skid used to support the tail when in contact with the ground. (Figs. 1, 4, 6, and 14.)

WING SKID.—A skid placed near the wing tip and designed to protect the wing from contact with the ground. (Fig. 1.)

SKIN FRICTION.—The tangential component of the fluid force at a point on a surface.

SLIP.—The difference between the mean geometrical pitch and the effective pitch. Slip is usually expressed as a percentage of the mean geometrical pitch.

SLIP FUNCTION.—The ratio of speed of advance through the undisturbed air to the product of propeller diameter by the number of revolutions in unit time. The slip function is the primary factor controlling propeller performance, i. e., $\left(\frac{V}{ND}\right)$.

SLIPSTREAM.—The stream of air driven astern by the propeller. (The indraft is sometimes included also.)

SOAR.—To gain, or at least not lose, altitude while flying without engine power.

SOUNDING BALLOON.—(*See* Balloon.)

SPAN (AIRFOIL).—The lateral dimensions of an airfoil, i. e., its dimension perpendicular to its chord. Its symbol is b.

SPAN (AIRPLANE).—The maximum distance measured parallel to the lateral axis from tip to tip of an airplane inclusive of ailerons. (Fig. 1.)

SPARS.—(*See* Wing spars.)

SPEED, CRITICAL.—The lowest speed of an airplane at which control can be maintained.

SPEED, MINIMUM.—The lowest steady speed which can be maintained by an airplane in level flight, with any throttle setting whatever.

SPIN.—A maneuver consisting of a combination of roll and yaw, with the longitudinal axis of the airplane inclined steeply downward. The airplane descends in a helix of large pitch and very small radius, the upper side of the airplane being on the inside of the helix, and the angle of attack on the inner wing being maintained at an extremely large value.

SPINNER.—A fairing, usually made of sheet metal and approximately conical or paraboloidal in form, which is attached to the propeller boss and revolves with it. (Fig. 1.)

SPIRAL INSTABILITY.—(*See* Stability.)

STABILITY.—That property of a body which causes it, when disturbed from a condition of equilibrium or steady motion, to develop forces or moments of such a character as to tend to restore the body to its original condition.

AUTOMATIC.—Stability dependent upon movable control surfaces automatically operated by mechanical means.

INHERENT.—Stability of an aircraft due solely to the disposition and arrangement of its fixed parts; i. e., that property which causes it, when disturbed, to return to its normal attitude of flight without the use of controls or the interposition of any mechanical devices.

DIRECTIONAL.—Stability with reference to rotations about the normal axis; i. e., an airplane possesses directional stability in its simplest form if a restoring moment comes into action when it is given a small angle of yaw. Owing to symmetry, directional stability is closely associated with lateral stability.

LATERAL.—Stability with reference to disturbances involving rolling, yawing, or side slipping; i. e., disturbances in which the position of the plane of symmetry of the aircraft is affected.

LONGITUDINAL.—Stability with reference to disturbances in the plane of symmetry; i. e., disturbances involving pitching and variation of the longitudinal and normal velocities.

SPIRAL INSTABILITY.—A type of instability inherent in certain airplanes which becomes evident when the airplane, as a result of a yaw, assumes too great a bank, and side slips; the bank continues to increase and the radius of the turn to decrease.

STATICAL STABILITY.—Stability of such a character that, if the airplane is displaced slightly from its normal attitude by rotation about an axis through its center of gravity (as may be done in wind tunnel experiments), moments come into play which tend to return the airplane toward its original attitude.

DYNAMICAL STABILITY.—Stability of such a character that, if the airplane is displaced from steady motion in flight, it tends to return to that steady state of motion, the oscillations due to restoring moments being damped out.

In a general way, the difference between static stability and dynamical stability is that the former depends on restoring moments alone, while the latter includes the action of damping factors.

STABILIZER.—A normally fixed surface at the rear end of an aircraft, approximately parallel to the plane of the longitudinal and lateral axes, whose function is to stabilize the pitching motion. (Also called "Tail plane.") (Fig. 1.)

STABILIZER, MECHANICAL.—A mechanical device to prevent an aircraft from departing from a condition of steady motion, or, in case such a motion is disturbed, to restore it to its steady state. Includes gyroscopic stabilizers, pendulum stabilizers, inertia stabilizers, etc.

STABILIZER SETTING, ANGLE OF.—(*See* Angle of stabilizer setting.)

STABLE OSCILLATION.—(*See* Oscillation, stable.)

STAGGER.—The amount of advance of the leading edge of an upper wing of a biplane, triplane, or multiplane over that of a lower, expressed either as percentage of gap or in degrees of the angle whose tangent is the percentage just referred to. It is considered positive when the upper wing is forward, and is measured from the leading edge of the upper wing along its chord to the point of intersection of this chord with a line drawn perpendicular to the chord of the upper wing at the leading edge of the lower wing, all lines being drawn in a plane parallel to the plane of symmetry. (Fig. 1.)

STAGGER WIRES.—(*See* Wires, stagger.)

STALLING.—A term describing the condition of an airplane which from any cause has lost the air speed necessary for control.

STATIC CEILING.—(*See* Ceiling, static.)

STATIC THRUST.—The thrust developed by a propeller when rotating at a fixed point.

STATION.—A term used to denote the location of a framing attachment in a fuselage or nacelle (strut points in a trussed fuselage, bulkhead points in a monocoque or veneer fuselage).

STATOSCOPE.—An instrument used to detect the existence of the minute changes in atmospheric pressure corresponding to small vertical motions of an aircraft.

STAY.—A wire or other tension member; for example, the stays of the wing and body trussing. (Fig. 1.)

STEP.—A break in the form of the bottom of a float or hull designed to assist in securing a dynamic reaction from the water.

STICK CONTROL.—(*See* Control stick.)

STREAMLINE.—The path of a small portion of a fluid relative to a solid body with respect to which the fluid is moving. The term is commonly used only of such flows as are not eddying, but the distinction should be made clear by the context.

STREAMLINE FLOW.—Flow past a solid body without any discontinuity in the pressure or velocity distribution.

STREAMLINE FORM.—A solid body which produces streamline flow.

STRUCTURAL DRAG.—(*See* Drag.)

STRUT.—A compression member of a truss frame. For instance, the vertical members of the wing truss of a biplane (interplane struts) and the short vertical and horizontal members separating the longerons (q. v.) in the fuselage. (Figs. 1.)

STRUT, DRAG.—(*See* Drag strut.)

SUPERCHARGED ENGINE.—(*See* Engine, supercharged.)

SUPERCHARGER.—A device for compressing the air supply of aircraft engines, usually intended to maintain normal sea-level pressure at the carburetor for all altitudes below a designed limiting value.

CENTRIFUGAL-TYPE.—A supercharging device comprising one or more high-speed rotors operating in a casing provided with diffusion vanes and, usually, also with entry guide vanes.

FAN-TYPE.—A supercharging device comprising one or more high-speed fan rotors operating in a casing not provided with diffusion or entry vanes.

POSITIVE BLOWER-TYPE.—A supercharging device comprising one or more relatively slow-speed rotors revolving in a stationary case in such a way as to provide a positive displacement.

POSITIVE DRIVEN-TYPE.—A supercharger driven at a fixed-speed ratio from the engine shaft by gears or other positive means.

SUPPORTING SURFACE, MAIN.—A set of wings, extending on the same general level from tip to tip of an airplane; e. g., a triplane has three main supporting surfaces. The main supporting surfaces include the ailerons, but no other surfaces intended primarily for control or stabilizing purposes.

SURFACE, BALANCED.—(*See* Balanced surface.)

SURFACE, CONTROL.—(*See* Control surface.)

SURFACE, MAIN SUPPORTING.—(*See* Supporting surface, main.)

SUSPENSION BAND.—The horizontal fabric band securely fastened to a balloon or airship, to which are attached the main suspensions of the basket or car. (Figs. 2 and 5.)

SUSPENSION BAR.—A wooden bar to which the supporting ropes of the car of a balloon are secured, fitted also with ropes and toggles for attaching to the car suspensions from the balloon. (Also called "Trapeze bar.") (Figs. 2 and 11.)

SUSPENSION LINES.—The system of lines, either cordage or metal, which supports weight attached to the envelope of a balloon or airship. (Figs. 2, 3, 5, and 11.)

SUSPENSION WINCH.—(*See* Winch suspension.)

SWEEP BACK.—The acute angle between the lateral axis of an airplane and the projection of the leading edge of the wing on a plane which includes the lateral and longitudinal axes. (Fig. 1.)

TAIL BOOM.—A spar or outrigger connecting the tail surfaces and main supporting surfaces. (Fig. 14.)

TAIL DROOP.—A deformation of an airship in which its longitudinal axis bends downward at the after end.

TAIL GROUP (or TAIL UNIT).—The stabilizing and control surfaces at the rear end of an aircraft, including stabilizer, fin, rudder, and elevator. (Also called "Empennage.")

TAIL HEAVY.—The condition of an aircraft in which, in normal flight, the tail tends to sink if the longitudinal control is released; i. e., the condition in which the pilot has to exert a push on the control stick or column to maintain the given attitude.

TAIL PLANE.—(*See* Stabilizer.)

TAIL SKID.—(*See* Skids.)

TAIL SLIDE.—The backward and downward motion, tail first, which certain airplanes may be made to take after having been brought into a stalling position by a steep climb.

TAIL UNIT.—(*See* Tail group.)

TANDEM AIRPLANE.—An airplane with two or more sets of wings of substantially the same area (not including the tail unit) placed one in front of the other and on about the same level.

TAXI.—To run an airplane over the ground, or a seaplane on the surface of water, under its own power.

THIMBLE.—A grooved ring of circular or heart-shaped form, generally of metal, which is inserted in the eye of a rope or wire to prevent chafing.

THRUST FACE.—(*See* Blade face.)

THRUST, PROPELLER.—(*See* Propeller thrust.)

TIPPING (PROPELLER).—A sheet metal (or equivalent) protective covering of the blade of a propeller near the tip, extended a short distance along the trailing edge and a considerable distance along the leading edge. (Fig. 1.)

TOGGLE.—A short crossbar of wood or metal, having a shouldered groove, which is fitted at the end of a rope at right angles to it. It is used for obtaining a quickly detachable connection with an eye at the end of another rope. (Fig. 2.)

TORQUE, PROPELLER.—(*See* Propeller torque.)

TORQUE, RUDDER.—(*See* Rudder torque.)

TOTAL PROPELLER WIDTH RATIO.—(*See* Propeller width ratio, total.)

TRACTOR AIRPLANE.—An airplane with the propeller or propellers forward of the main supporting surfaces. (Figs. 1, 6, and 10.)

TRACTOR PROPELLER.—(*See* Propeller, tractor.)

TRAIL ROPE.—(*See* Drag rope.)

TRAILING EDGE.—The rearmost edge of an airfoil or propeller blade. (Fig. 1.)

TRAJECTORY BAND.—A band of webbing carried in a curve over the top of the envelope of an airship to distribute the stresses due to the suspension. (Fig. 13.)

TRAPEZE BAR.—(*See* Suspension bar.)

TRIPLANE.—An airplane with three main supporting surfaces, placed one above another.

TURN INDICATOR.—An instrument indicating when the direction of the line of flight, or of its projection on a horizontal plane, is changing.

TURN METER.—An instrument similar to a turn indicator but which gives quantitatively the rate of turn in terms of the angular velocity or the radius of curvature.

UNSTABLE OSCILLATION.—(*See* Oscillation, unstable.)

USEFUL LOAD.—(*See* Load.)

V WIRES.—The lower lines of the winch suspension of the kite balloon. They meet at the junction piece and form V's, hence the name. (Fig. 2.)

VALVE, AUTOMATIC.—A spring-controlled safety valve fitted to an envelope or gas bag for the purpose of preventing excessive internal pressure. (Figs. 4 and 5.)

VALVE COVER.—(*See* Bonnet.)

VARIABLE COMPRESSION ENGINE.—(*See* Engine, variable compression.)

VENEER.—Thin sheets of wood, either sliced with a knife or sawed.

VENTURI TUBE.—A short tube with flaring ends and a constriction between them, into which a side tube opens. When fluid flows through the venturi, there is a reduction of pressure in the constriction, the amount of the reduction being a function of the velocity of flow. The reduced pressure may be measured by means of the side tube. (Fig. 8.)

The Venturi is usually combined with a Pitot tube or with one giving static pressure, to form a pressure nozzle, which may be used to determine the speed of an aircraft through the air.

VERTIMETER.—An instrument indicating on a scale the minute changes of atmospheric pressure corresponding to small vertical motions of aircraft.

WARP.—To change the form of a wing by twisting it. Warping is sometimes used to maintain the lateral equilibrium of an airplane.

WASH.—The disturbance in the air produced by the passage of an airfoil. (Also called the "wake," in the general case for any solid body.)

WASHIN.—Permanent warping of the wing which results in an increase in the angle of attack near the tip.

WASHOUT.—Permanent warping of a wing which results in a decrease in the angle of attack near the tip.

WEIGHT, DISCHARGEABLE.—(*See* Dischargeable weight.)

WEIGHT PER HORSEPOWER.—The dry weight of an engine divided by the normal horsepower.

WHEEL CONTROL.—(*See* Control column.)

WIDTH RATIO.—(*See* Propeller width ratio.)

WINCH SUSPENSION.—The rigging by means of which the drag of the kite balloon is transmitted from the envelope to the towing or traction cable. (Fig. 2.)

WIND CONE.—A sleeve of light fabric shaped like a truncated cone when inflated and suspended by one end from a rigid support. When suitably suspended, if there is a wind it stands out nearly horizontally and indicates its direction, or in the absence of a wind it is not inflated and thus indicates the fact.

WIND, RELATIVE.—(*See* Relative wind.)

WIND TUNNEL.—An elongated chamber through which a steady air stream may be drawn by a suction fan. Models of airfoils of aircraft or of propellers may be placed in the middle portion of the tunnel, called the experimental chamber, and supported by suitable balances placed outside the air stream, so that the forces, moments, etc., due to the moving air may be measured.

WINDMILL.—An air-driven screw fitted with blades somewhat similar to those of a propeller and used to drive auxiliary apparatus.

WING.—The portion of single main supporting surface on either side of the plane of symmetry; e. g., a biplane has four wings. (Figs. 1, 9, 10, and 14.)

WING DRAG.—(*See* Drag.)

WING LOADING.—The gross weight of an airplane, fully loaded, divided by the area of the supporting surface. The area used in computing the wing loading should include ailerons, but not the stabilizer or elevators.

WING RIB.—A fore-and-aft member of the wing structure of an airplane, used to give the wing section its form and to transmit the load from the fabric to the spars. (Figs. 1 and 15.)

RIB, COMPRESSION.—A heavy rib designed to have the above functions and also to act as a strut opposing the pull of the wires in the internal drag truss. (Also called "Drag strut.") (Figs. 1 and 15.)

RIB, FORMER OR FALSE.—An incomplete rib, frequently consisting only of a strip of wood extending from the leading edge to the front spar, which is used to assist in maintaining the form of the wing where the curvature of the airfoil section is sharpest. (Figs. 1 and 15.)

WING SETTING, ANGLE OF.—(*See* Angle of wing setting.)

WING SKID.—(*See* Skids.)

WING SPARS.—The principal transverse structural members of the wing assembly of an airplane. (Figs. 1 and 15.)

WING TRUSS.—The framing by which the wing loads of an airplane are transmitted to the fuselage; comprises struts, wires, cables, tie-rods, and spars.

WIRE.—In aeronautics refers specifically to drawn solid wire.

WIRES, ANTIDRAG.—Wires designed primarily to resist forces acting parallel to the chords of the wings of an airplane and in the same direction as the direction of flight. They are, in general, inclosed in the wings. (Fig. 1.)

WIRES, ANTILIFT.—Wires designed primarily to resist forces in the opposite direction to the normal direction of the lift, and to oppose the lift wires and prevent distortion of the structure by overtightening of those members. (Sometimes called "Landing wires.") (Fig. 1.)

WIRES, DRAG.—All wires or cables designed primarily to resist drag forces.

INTERNAL DRAG WIRES are concealed inside the wings. (Fig. 1.)

EXTERNAL DRAG WIRES run from a wing cell to the nose of the fuselage or some other part of the airplane. (Fig. 1.)

WIRES, LIFT.—The wires or cables which transmit the lift on the outer portion of the wings of an airplane in toward the fuselage or nacelle. These wires usually run from the top of an interplane strut to the bottom of the strut next nearer the fuselage. (Fig. 1.)

WIRES, STAGGER.—Wires connecting the upper and lower surfaces of an airplane and lying in planes substantially parallel to the plane of symmetry. (Also called "Incidence wires.") (Fig. 1.)

YAW, ANGLE OF.—(*See* Angle of yaw.)

YAWMETER.—An instrument giving by direct reading the angle of yaw.

YOKE.—(*See* Control column.)

ZERO LIFT ANGLE.—(*See* Angle, zero lift.)

ZERO LIFT LINE.—A line through the trailing edge of an airfoil section parallel to the direction of the wind when the lift is zero.

ZOOM.—To climb for a short time at an angle greater than that which can be maintained in steady flight, the airplane being carried upward at the expense of its kinetic energy. This term is sometimes used as a noun, to denote any sudden increase in the upward slope of the flight path.

REPORT No. 157.

NOMENCLATURE FOR AERONAUTICS.

By the National Advisory Committee for Aeronautics.

PART II.

NOMENCLATURE BY DIVISIONS.

A. GENERAL TERMS.

AERONAUTICS.—The science and art of self-sustained flight in air.

AIRCRAFT.—Any man-carrying device or structure designed to be supported by the air, making use either of buoyancy or of the dynamic action of the air.

AEROSTATION.—The art of operating lighter-than-aircraft.

AVIATION.—The art of operating heavier-than-aircraft.

AERODYNAMICS.—The branch of dynamics which treats of the motion of air and other gaseous fluids, and of the forces on solids in motion relative to such fluids.

AEROSTATICS.—The science that treats of the equilibrium of gaseous fluids and of solid bodies immersed in them.

As an aeronautic term it relates to those properties of lighter-than-aircraft which are due to the buoyancy of the air.

AIRWAY.—An aerial highway, developed by the provision of landing fields, radio stations, etc., for transportation between three or more traffic centers or extending across a large geographical area.

AIR ROUTE.—An aerial highway between two traffic centers, or leading from a traffic center into an airway.

AIRPORT.—The terminal of an airway.

CROSS-COUNTRY FLIGHT.—A flight starting at one landing field and terminating at another not within gliding distance of the former.

PILOT.—An operator of aircraft. This term is applied regardless of the sex of the operator.

B. TYPES OF AIRCRAFT.

AEROSTAT.—An aircraft whose support is chiefly due to buoyancy, its interior being occupied in the main by one or more bags or cells filled with a gas lighter than the surrounding air. Same as lighter-than-air craft.

AIRPLANE.—A mechanically driven aircraft heavier than air, fitted with fixed wings, and supported by the dynamical action of the air.

GLIDER.—A form of aircraft similar to an airplane, but without a power plant.

HELICOPTER.—A form of aircraft heavier than air whose chief support in the air is derived from the vertical thrust of propellers.

KITE.—A structure heavier than air, without other propelling means than the towline pull, the support being derived from the wind moving past its surfaces.

ORNITHOPTER.—A form of aircraft heavier than air deriving its chief support and propelling force from flapping wings.

PARACHUTE.—An apparatus used to retard the descent of a falling body by offering resistance to its motion through the air; usually made of light fabric, so that it may be packed in a small space in such a manner that it will readily unfold when released with a falling body attached.

(Strictly speaking, not an aircraft.)

C. TYPES OF AEROSTATS.

AIRSHIP.—An aerostat provided with a propelling system and with means of controlling the direction of motion. If its power plant is not operating, it acts like a balloon.

NONRIGID.—An airship whose form is maintained by the internal pressure in the gas bags and ballonets. (Fig. 3.)

RIGID.—An airship whose form is maintained by a rigid structure. (Fig. 4.)

SEMIRIGID.—An airship whose form is maintained by means of a rigid or jointed keel, in combination with internal pressure in the gas containers and ballonets. (Fig. 5.)

BALLOON.—An aerostat the form of which is maintained by the pressure of a contained gas lighter than the surrounding air, and which has neither power plant nor means of controlling the direction of flight in a horizontal plane.

BARRAGE.*—A small captive balloon, used to support wires or nets which are intended as a protection against attacks by airplanes.

CAPTIVE.—A balloon restrained from free flight by means of a cable attaching it to the earth.

FREE.—A balloon, usually spherical, whose ascent and descent may be controlled by use of ballast or with a loss of the contained gas, and whose direction of flight is determined by the wind. (Fig. 11.)

KITE.—An elongated form of captive balloon, fitted with lobes to keep it headed into the wind, and usually deriving increased lift due to its axis being inclined to the wind. (Fig. 2.)

NURSE.*—A small balloon made of heavy fabric, employed as a portable means for storing gas.

PILOT.*—A small balloon sent up to show the direction and speed of the wind.

SOUNDING.*—A small balloon sent up without passengers but with recording meteorological instruments.

D. TERMS RELATING TO AEROSTATS.

(*a*) *OPERATION.*

INFLATION.—The act of filling a balloon or airship with gas in preparation for flight.

INFLATION MANIFOLD.—A metal connection with numerous inlets which permits the passage of gas at one time from a number of sources—either cylinders or gas holders—to the main inflation tube.

GASSING—The operation of replenishing the balloon with fresh gas to increase its purity or to make up for loss of gas due to leakage.

DEFLATION.—The act of removing gas from an aerostat.

DEFLATION SLEEVE.—A sleeve or appendix fitted on the lower lobe of a kite balloon and used to permit the rapid escape of the air in the lobes when the balloon is hauled down. (Fig. 2.)

BALLAST.—Any substance, usually sand or water, taken in a balloon or airship and intended to be thrown out, if necessary, for the purpose of reducing the load carried, and thus altering the aerostatic relations. (Figs. 4 and 5.)

DRAG ROPE.—A long rope attached by one end to a toggle in the concentration ring of a free balloon, and which can be hung overboard so as to act as a brake and a variable ballast in making a landing. On airships a similar rope is used as a grab or mooring line by the landing party, and is sometimes called the grab line. Same as Trail rope. (Figs. 2, 3, 4 and 5.)

DANGER CONES.—Pendents on the wire cable of a captive balloon, usually hollow cones of light cloth, to warn aircraft of its presence.

HOG.—A distortion of an airship in which the longitudinal axis becomes convex upward, or both ends droop.

*Those forms of ballons marked with an asterisk (*) are not, strictly speaking, aircraft.

D. TERMS RELATING TO AEROSTATS—Continued.

(*a*) *OPERATION*—Continued.

SAG.—A distortion of an airship in which the longitudinal axis becomes concave upward, or both ends rise.

TAIL DROOP.—A deformation of an airship in which its longitudinal axis bends downward at the after end.

PERFORMANCE CHARACTERISTICS.—For an airship are, in general:

(*a*) Maximum speed at various altitudes.

(*b*) Maximum altitude attainable with definite weight relations and ballonet volume (if fitted).

(*c*) Endurance at full and half power.

(*d*) Static ceiling.

(*e*) Dynamic lift under specified conditions.

(*b*) *PRINCIPAL PARTS.*

GAS CONTAINER.—The bag or cell that contains the hydrogen or aerostatic gas. (Figs. 4 and 5.)

HULL.—The main structure of a rigid airship, consisting of a covered elongated framework which incloses the gas bags and supports the cars and equipment. (Fig. 4.)

CHORD WIRES.—Wires joining the vertices of the polygonal frame of the main transverse of the rigid airship. (Fig. 4.)

OUTER COVER.—The outside covering of the hull of a rigid airship, usually of fabric. (Fig. 4.)

ENVELOPE.—The outside gas-containing fabric of a nonrigid or semirigid airship or balloon. It may be divided by diaphragms into separate gas compartments or cells, and may also contain internal air cells or ballonets. (Figs. 3, 5 and 11.)

GORE.—The portion of the envelope of a balloon or airship included between two adjacent meridian seams.

KEEL.—A member or assembly of members which contributes longitudinal strength to an airship of the rigid or semirigid type. In either case the keel is usually an elaborately trussed girder and may be inclosed within the envelope or may project below the regular cross-sectional form of the envelope. (Figs. 4 and 5.)

ARTICULATED.—A keel made up of a series of members connected at their ends by hinged joints. (Fig. 5.)

LOBES.—Air inflated bags at the stern of a kite balloon designed to give it directional stability. They may act as fins or stabilizers. (Fig. 2.)

BALLONET.—A chamber constructed of fabric within the interior of a balloon or airship for the purpose of controlling the ascent or descent by altering the aerostatic relations and for maintaining the pressure of the gas in the envelope so as to prevent deformation. The ballonet is kept inflated with air at the required pressure, under the control of valves by a blower or by the action of the wind caught in an air scoop. (Figs. 2, 3 and 5.)

BALLONET DIAPHRAGM.—The fabric partitions between the gas and air compartments of the envelope of a nonrigid or semirigid airship or kite balloon.

BOW STIFFENERS.—Rigid members attached to the bow of a nonrigid or semirigid envelope to reinforce it against the pressure caused by the motion of the airship Often called nose stiffeners or nose battens. (Figs. 3 and 5.)

BOW CAP.—A cap of metal or fabric used to reinforce the extreme forward ends of the bow stiffeners. Also called nose cap. (Figs. 3, 4, and 5.)

CAR.—That part of the structure of an airship arranged for carrying personnel, cargo, equipment, or power unit. (Figs. 3, 4, and 5.)

BASKET.—The car suspended beneath a balloon for carrying passengers, ballast, etc. (Figs. 2 and 11.)

D. TERMS RELATING TO AEROSTATS—Continued.

(c) *DETAILED PARTS AND FITTINGS.*

CONCENTRATION RING (LOAD RING):

AIRSHIP.—A ring to which several rigging lines are brought from the envelope and from which one or more lines also lead to the car.

FREE BALLOON.—A ring to which are attached the ropes suspending the basket and to which the net is also secured. (Fig. 11.)

BRIDLE.—A sling or cordage which has its ends attached to the suspension band of a captive balloon or airship, or to intermediate points of preceding bridles, and itself supporting from an intermediate point the end of another bridle or a suspension rope.

CROW'S-FOOT.—A system of diverging short ropes for distributing the pull of a single rope.

SUSPENSION LINES.—The system of lines, either cordage or metal, which supports weight attached to the envelope of a balloon or airship. (Figs. 2, 3, 5, and 11.)

SUSPENSION BAND.—The horizontal fabric band securely fastened to the envelope of a balloon or airship, to which are attached the main suspensions of the basket or car. (Figs. 2 and 5.)

TRAJECTORY BAND.—A band of webbing carried in a curve over the top of the envelope of an airship to distribute the stresses due to the suspension. (Fig. 13.)

PATCH.—A strengthened or reinforced flap of fabric, which is cemented to the envelope and forms an anchor by which some portion of the structure is attached to the envelope. (Fig. 12.)

DRIP BAND.—A strip of fabric attached by one edge to the envelope of an aerostat so that rain runs off its free edge instead of dripping into the basket or car. The drip band also assists in keeping the suspension ropes dry and nonconducting.

RIP PANEL.—A strip in the upper part of the envelope of a balloon or semirigid or nonrigid airship which is torn off or ripped when immediate deflation is desired. (Figs. 2 and 3.)

RIP CORD.—The rope running from the rip panel to the car or basket, the pulling of which tears off or rips the rip panel and causes immediate deflation. (Figs. 2 and 3.)

SAFETY LOOP.—A loop formed immediately outside the fitting through which the rip cord emerges from the bottom of an aerostat. Before the rip panel can be opened by the rip cord, the fastening of this safety loop must be torn off by a strong pull on the cord.

BONNET.—The appliance, having the form of a hood or parasol, which protects the valve of an airship or balloon against rain. (Also called "Valve cover.") (Figs. 2, 4, and 5.)

MOORING LINE.—A line attached near the bow of an airship by which it may be secured to the ground or to a mooring mast. (Figs. 3, 4, and 5.)

MOORING CONE.—The grooved conical member which engages with a hollow cone at the top of the mooring mast and provides the coupling between the rigid airship and the mooring mast. (Fig. 4.)

MOORING CONE OUTRIGGER.—The member, usually tubular, which supports the mooring cone at the bow of the rigid airship. (Fig. 4.)

WINCH SUSPENSION.—The rigging by means of which the drag of the kite balloon is transmitted from the envelope to the towing or traction cable. (Fig. 2.)

V WIRES.—The lower lines of the winch suspension of the kite balloon. They meet at the junction piece and form V's, hence the name. (Fig. 2.)

HANDLING LINES.—Lines attached along the sides of an airship for use in handling near and on the ground. (Figs. 2, 3, 4, and 5.)

D. TERMS RELATING TO AEROSTATS—Continued.

(c) DETAILED PARTS AND FITTINGS—Continued.

FIELD HANDLING FRAME.—A portable frame, usually made of tubing and braced with wires, which is attached to the rigid airship when it is on the ground, and is intended to afford a grasp to more men than could get on the handling rails of the cars. These frames are rarely carried when in flight. (Fig. 4.)

MOORING HARNESS.—A system of bands of tape over the top of a balloon to which are attached the mooring ropes.

MOORING ROPES.—Lines attached to the mooring harness of a balloon for use in securing it to the ground. (Fig. 2.)

MOORING BAND.—A band of tape or webbing over the top of a kite balloon to which are attached the mooring ropes. It forms part of a mooring harness. (Fig. 2.)

MOORING LOOPS.—A system of cordage loops on the envelope of a kite balloon for suspending sandbags.

NET:

FREE BALLOON.—A rigging made of ropes and twine shaped to the upper surface of the envelope, which supports the weight of the basket, etc., distributing the load over the entire upper surface of the envelope. (Fig. 11.)

INFLATION.—A rectangular net of cordage used to restrain the envelope of a kite balloon or airship during inflation and before the car is attached.

RIGID BALLOON.—A netting of cord, usually ramie, of small mesh which receives the first lift from the gas cells and imparts this lift to a wire netting of coarser mesh, both being fitted between the horizontals. (Fig. 4.) It may be compared to the net of a free balloon.

APPENDIX.—The tube at the bottom of a balloon, used for inflation and deflation. In the case of a spherical balloon it also serves to increase the "head" of gas, and so to build up an internal pressure sufficient to keep the envelope from being pulled out of shape by the weight of the basket. (Fig. 11.)

APPENDIX MANHOLE.—An appendix in the kite balloon of large diameter and usually rather short. It is used more for access than for inflation or deflation. (Fig. 2.)

INFLATION SLEEVE (or FILLING SLEEVE).—A tubular fabric attachment to an envelope or gas bag, serving as a lead for the inflating hose. (Figs. 3 and 5.)

NURSING TUBE.—An elongated appendix or inflation sleeve, of the kite balloon, which is brought down to the basket and fitted with a quick connection coupling. This coupling can be attached to a similar piece on a tube on the deck of the ship and gas may be sent into the balloon within a few minutes after it has reached the deck. (Fig. 2.)

AUTOMATIC VALVE.—A spring-controlled safety valve fitted to an envelope or gas bag for the purpose of preventing excessive internal pressure. (Figs. 4 and 5.)

PRESSURE TUBE.—A tube fitted to the side of an envelope or gas bag, to which a pressure gauge may be attached.

GLAND.—A short tube fitted to an envelope or gas bag in such a manner that a rope or line may pass through without leakage of gas or air. (Figs. 2 and 5,)

AIR DUCT.—The duct which joins the vertical to the lateral lobes of a kite balloon; also supplies air to the ballonet blower of a semirigid airship. (Figs. 2 and 5.)

AIR SCOOP.—A projecting scoop, which uses the wind or slipstream to maintain air pressure in the interior of the ballonet of an aerostat. (Fig. 2, 3, and 12.)

A similar device is sometimes used on airplanes to produce ventilation. (Fig. 4.)

TOGGLE.—A short crossbar of wood or metal, having a shouldered groove, which is fitted at the end of a rope at right angles to it. It is used for obtaining a quickly detachable connection with an eye at the end of another rope. (Fig. 2.)

D. TERMS RELATING TO AEROSTATS—Continued.

(*c*) *DETAILED PARTS AND FITTINGS*—Continued.

BATONET.—A small cylindrical piece of wood, or other material by means of which the rigging of the balloon or airship is attached to a fabric loop on the envelope. (A special form of toggle.)

JACKSTAY.—A longitudinal rigging provided to maintain the correct distance between the heads of various rigging parts on an aerostat.

SUSPENSION BAR.—A wooden bar to which the supporting ropes of the car of a balloon are secured, fitted also with ropes and toggles for attaching to the car suspensions from the balloon. (Also called "Trapeze bar.") (Fig. 2.)

THIMBLE.—A grooved ring of circular or heart-shaped form, generally of metal, which is inserted in the eye of a rope or wire to prevent chafing.

D RING.—A ring having, as the name implies, the shape of a capital D, to which rope suspensions are attached.

CORD GROMMET.—A small ring of cord.

(*d*) *MISCELLANEOUS TERMS.*

BUOYANCY:

CENTER OF.—The center of gravity of the air displaced by a balloon or airship. (It is approximately the center of gravity of the contained gas.)

GROSS.—The total upward force on an aerostat at rest; the total volume multiplied by the difference of weight density of the air and the contained gas.

There is said to be a condition of positive buoyancy if the gross buoyancy of an aerostat is greater than its weight; but if the gross buoyancy is less than the weight, the condition is described as one of negative buoyancy.

CAPACITY.—The volume, under specified conditions, of the gas-containing portion of an aerostat. For balloons and nonrigid airships this is the volume of the envelope completely inflated to normal pressure, with air ballonets empty; for rigid airships, it is the nominal volume of the gas cells at a standard degree of inflation, usually 95 per cent.

DISCHARGEABLE WEIGHT.—The excess of the gross buoyancy of an aerostat over the sum of the dead load and the weight of the crew and such items of equipment as are essential to enable an airship to fly and land safely.

CEILING STATIC.—The altitude to which an airship will rise statically after removal of all dischargeable weights.

MANOMETER PRESSURE.—The excess of pressure inside the envelope of an aerostat over the atmospheric pressure. In the case of an airship, the point of reference for the excess of pressure is the bottom of the gas cell.

PERMEABILITY.—The measure of the rate of diffusion of gas through intact balloon fabric, usually expressed in liters per square meter of fabric per 24 hours, under standard conditions of pressure and temperature.

PURITY (OF HYDROGEN OR OTHER AEROSTATIC GAS).—The ratio of the pressure of the hydrogen (or other aerostatic gas) in the container to the total pressure due to all the contained gases.

E. TYPES OF AIRPLANES.

AMPHIBIAN.—An airplane designed to rise from and alight on either land or water.

SEAPLANE.—An airplane designed to rise from and alight on the water.

BOAT SEAPLANE (or FLYING BOAT).—A form of seaplane having for its central portion a hull or boat which provides flotation in addition to serving as a fuselage. It is often provided with auxiliary floats or pontoons for lateral support on the water. (Fig. 9.)

FLOAT SEAPLANE.—A form of seaplane fitted with one or more floats or pontoons instead of a hull. (Fig. 10.)

E. TYPES OF AIRPLANES—Continued.

LANDPLANE.—An airplane designed to rise from and alight on the land. (Figs. 1, 6, and 14.)

SHIPPLANE.—A land plane designed to rise from and alight on the deck of a ship.

PUSHER.—An airplane with the propeller or propellers in the rear of the main supporting surfaces. (Figs. 9 and 14.)

TRACTOR.—An airplane with the propeller or propellers forward of the main supporting surfaces. (Figs. 1, 6, and 10.)

MONOPLANE.—An airplane which has but one main supporting surface, sometimes divided into two parts by the fuselage. (Fig. 6.)

MULTIPLANE.—An airplane with two or more main supporting surfaces, placed one above another.

BIPLANE.—An airplane with two main supporting surfaces, placed one above another. (Fig. 1.)

TRIPLANE.—An airplane with three main supporting surfaces, placed one above another.

QUADRUPLANE.—An airplane with four main supporting surfaces, placed one above another.

TANDEM.—An airplane with two or more sets of wings of substantially the same area (not including the tail unit), placed one in front of the other and on about the same level.

F. TERMS RELATING TO AIRPLANES.

(*a*) *OPERATION AND MANEUVERS.*

BANK.—To incline an airplane laterally; i. e., to rotate it about its longitudinal axis. Right bank is to incline the airplane with the right wing down.

Also used as a noun to describe the position of an airplane when its lateral axis is inclined to the horizontal.

BARREL ROLL.—A maneuver in which a complete revolution about the longitudinal axis is made, the horizontal direction of flight being approximately maintained.

LOOP.—A maneuver in which the airplane describes an approximately circular path in the plane of symmetry, the lateral axis remaining horizontal and the upper side of the airplane remaining on the inside of the circle.

REVERSE TURN.—A rapid maneuver to reverse the direction of flight of an airplane, made by a half loop and half roll.

SPIN.—A maneuver consisting of a combination of roll and yaw, with the longitudinal axis of the airplane inclined steeply downward. The airplane descends in a helix of large pitch and very small radius, the upper side of the airplane being on the inside of the helix and the angle of attack on the inner wing being maintained at an extremely large value.

SIDE SLIPPING.—Flight in which the lateral axis is inclined and the airplane has a component of velocity in the direction of its lower end. When it occurs in connection with a turn it is the opposite of skidding (q. v.).

SKIDDING.—Sliding sidewise away from the center of curvature when turning. It is usually caused by banking insufficiently and is the opposite of side slipping (q. v.).

PANCAKE.—To "level off" an airplane at a greater altitude than in a normal landing, causing it to stall and descend with the wings at a very large angle of attack and approximately without bank, on a steeply inclined path.

GLIDE.—To descend at a normal angle of attack without engine power sufficient for level flight, the propeller thrust being replaced by a component of gravity along the line of flight. Also used as a noun.

DIVE.—A steep glide or flight.

F. TERMS RELATING TO AIRPLANES—Continued.

(*a*) *OPERATION AND MANEUVERS*—Continued.

SOAR.—To gain, or at least not lose, altitude, while flying without engine power.

TAXI.—To run an airplane over the ground, or a seaplane on the surface of water, under its own power.

ZOOM.—To climb for a short time at an angle greater than that which can be maintained in steady flight, the airplane being carried upward at the expense of its kinetic energy. This term is sometimes used as a noun, to denote any sudden increase in the upward slope of the flight path.

STALLING.—A term describing the condition of an airplane which from any cause has lost the air speed necessary for control.

NOSE HEAVY.—The condition of an aircraft in which, in normal flight, the nose tends to drop if the longitudinal control is released; i. e., the condition in which the pilot has to exert a pull on the control stick or column to maintain the given attitude.

TAIL HEAVY.—The condition of an aircraft in which, in normal flight, the tail tends to sink if the longitudinal control is released; i. e., the condition in which the pilot has to exert a push on the control stick or column to maintain the given attitude.

TAIL SLIDE.—The backward and downward motion, tail first, which certain airplanes may be made to take after having been brought into a stalling position by a steep climb.

CRITICAL SPEED.—The lowest speed of an airplane at which control can be maintained.

MINIMUM SPEED.—The lowest steady speed which can be maintained by an airplane in level flight, with any throttle setting whatever.

WARP.—To change the form of a wing by twisting it. Warping is sometimes used to maintain the lateral equilibrium of an airplane.

CEILING:

ABSOLUTE.—The maximum height above sea level which a given airplane could reach theoretically, assuming standard air conditions.

SERVICE.—The height above sea level, assuming standard air conditions, at which a given airplane ceases to be able to rise at a rate higher than a small specified one (100 feet per minute in the United States and England). This specified rate may be different in different countries.

PERFORMANCE CHARACTERISTICS.—For an airplane are as follows:

(*a*) Maximum and minimum speed at various altitudes.
(*b*) Rates of climb at various altitudes.
(*c*) Time to climb to various altitudes.
(*d*) The service ceiling.
(*e*) The absolute ceiling.
(*f*) The landing speed or minimum speed.
(*g*) Power plant characteristics corresponding to above.

POWER LOADING.—The gross weight of an airplane fully loaded divided by the normal brake horsepower of the engine computed for air of standard density, unless otherwise stated.

(*b*) *WING PARTS.*

WING.—The portion of a single main supporting surface on either side of the plane of symmetry; e. g., a biplane has four wings. (Figs. 1, 9, 10, and 14.)

MAIN SUPPORTING SURFACE.—A set of wings, extending on the same general level from tip to tip of an airplane; e. g., a triplane has three main supporting surfaces. The main supporting surfaces include the ailerons, but no other surfaces intended primarily for control or stabilizing purposes.

F. TERMS RELATING TO AIRPLANES—Continued.

(*b*) *WING PARTS*—Continued.

BAY.—The cubical or prismoidal section of a trussing included between two transversely adjacent sets of struts or bulkheads. The first bay of the wing trussing of an airplane is the one adjacent to the plane of symmetry.

CELL.—The entire structure of the wings and wing trussing on one side of the fuselage of an airplane, or between fuselages or nacelles, where there are more than one; i. e., two or more bays.

PANEL.—A separately constructed portion of a wing which is attached to the remainder by bolts and fittings.

AILERON.—A hinged or pivoted movable auxiliary surface of an airplane, usually part of the trailing edge of a wing, the primary function of which is to impress a rolling moment on the airplane. (Fig. 1.)

SKID FINS.—Fore-and-aft vertical surfaces, usually placed above the upper wings, designed to provide vertical keel surface and so to increase lateral stability. (Figs. 9 and 10.)

DRAG WIRES.—All wires or cables designed primarily to resist drag forces.

INTERNAL DRAG WIRES are concealed inside the wings. (Fig. 1.)

EXTERNAL DRAG WIRES run from a wing cell to the nose of the fuselage or some other part of the airplane. (Fig. 1.)

ANTIDRAG WIRES.—Wires designed primarily to resist forces acting parallel to the chords of the wings of an airplane and in the same direction as the direction of flight. They are, in general, inclosed in the wings. (Fig. 1.)

LIFT WIRES.—The wires or cables which transmit the lift on the outer portion of the wings of an airplane in toward the fuselage or nacelle. These wires usually run from the top of an interplane strut to the bottom of the strut next nearer the fuselage. (Fig. 1.)

ANTILIFT WIRES.—Wires designed primarily to resist forces in the opposite direction to the normal direction of the lift, and to oppose the lift wires and prevent distortion of the structure by overtightening of those members. (Sometimes called "Landing wires.") (Fig. 1.)

STAGGER WIRES.—Wires connecting the upper and lower surfaces of an airplane and lying in planes substantially parallel to the plane of symmetry. (Also called "Incidence wires.") (Fig. 1.)

WING TRUSS.—The framing by which the wing loads of an airplane are transmitted to the fuselage; comprises struts, wires, cables, tie-rods, and spars.

KING POST.—The main compression member of a trussing system applied to support a single member subject to bending. (Figs. 4 and 6.)

DRAG STRUT.—A fore-and-aft compression member of the internal bracing system of a wing. (Figs. 1 and 15.)

WING RIB.—A fore-and-aft member of the wing structure of an airplane, used to give the wing section its form and to transmit the load from the fabric to the spars. (Figs. 1 and 15.)

RIB COMPRESSION.—A heavy rib designed to have the above functions and also to act as a strut opposing the pull of the wires in the internal drag truss. (Also called Drag strut.) (Figs. 1 and 15.)

RIB, FORMER OR FALSE.—An incomplete rib, frequently consisting only of a strip of wood extending from the leading edge to the front spar, which is used to assist in maintaining the form of the wing where the curvature of the airfoil section is sharpest. (Figs. 1 and 15.)

WING SPARS.—The principal transverse structural members of the wing assembly of an airplane. (Figs. 1 and 15.)

F. TERMS RELATING TO AIRPLANES—Continued.

(*b*) *WING PARTS*—Continued.

CABANE.—A pyramidal or prismoidal framework for supporting the wings at the fuselage. Also applied to the system of trussing used to support overhang in a wing. (Figs. 6, 9, and 10.)

TAIL BOOM.—A spar or outrigger connecting the tail surfaces and main supporting surfaces. (Fig. 16.)

(*c*) *BODY PARTS.*

BODY.—The fuselage or hull (including cowling and covering) or nacelle (including cowling and covering) and nacelle mounting. (Figs. 1, 4, and 9.)

FUSELAGE.—The elongated structure, of approximately streamline form, to which are attached the wings and tail unit of an airplane. In general it contains the power plant, passengers, cargo, etc. (Fig. 1.)

MONOCOQUE FUSELAGE.—A type of fuselage construction wherein the structure consists of a thin shell of wood or metal, supported by bulkheads. The shell is designed to carry all stresses arising in the fuselage.

SEMIMONOCOQUE FUSELAGE.—A type of fuselage construction wherein the structure consists of a thin shell of wood or metal supported by a framework of bulkheads and longerons. The latter are designed to take stresses in bending, while the shell is designed to take the shearing stresses.

VENEER FUSELAGE.—A type of fuselage which is built up by covering a framework of longerons and bulkheads with a plywood skin.

NACELLE.—An inclosed shelter for passengers or for a power plant. A nacelle is usually shorter than a fuselage, and does not carry the tail unit.

COCKPIT.—The open spaces in which the pilot and passengers are accommodated. (Fig. 1.) When the cockpit is completely housed in it is called a cabin.

BULKHEAD.—A transverse structural member of a fuselage or nacelle, continuous around a periphery.

BAY.—The cubical or prismoidal section of a trussing included between two adjacent bulkheads.

LONGERON.—A fore-and-aft member of the framing of an airplane fuselage or nacelle, usually continuous across a number of points of support. (Fig. 1.)

STATION.—A term used to denote the location of a framing attachment in a fuselage or nacelle (strut points in a trussed fuselage, bulkhead points in a monocoque or veneer fuselage).

FIRE WALL.—A fire-resistant transverse bulkhead, so set as to isolate the engine compartment from the other parts of the structure, and thus to reduce the risk from fire in the engine compartment. (Fig. 1.)

COWLING.—A removable covering which extends over or around the engine, and sometimes over a portion of the fuselage or nacelle as well. (Fig. 1.)

(*d*) *LANDING GEAR PARTS.*

LANDING GEAR.—The understructure of an aircraft designed to carry the load when in contact with the land or water. There are four types—boat type, float type, skid type, and wheel type. (Figs. 1, 6, 9, 10, and 14.)

FLOAT (or PONTOON).—A completely inclosed water-tight structure attached to an aircraft in order to furnish it buoyancy when in contact with the surface of the water. In float seaplanes the crew is carried in a fuselage or nacelle separate from the float. (Fig. 10.)

HULL.—The portion of a boat seaplane which furnishes buoyancy when in contact with the surface of the water. The main supporting surfaces are attached to it and it contains accommodations for the crew and passengers. (Fig. 9.)

FLOTATION GEAR.—An emergency gear attached to a land plane to permit alighting on the water and to provide buoyancy when resting on the surface of the water.

F. TERMS RELATING TO AIRPLANES—Continued.

(*d*) *LANDING GEAR PARTS*—Continued.

STEP.—A break in the form of the bottom of a float or hull designed to assist in securing a dynamic reaction from the water.

SKIDS.—Runners used as members of the landing gear and designed to aid the air craft in landing or taxying.

TAIL SKID.—A skid used to support the tail when in contact with the ground. (Fig. 1, 4, 6, and 14.)

WING SKID.—A skid placed near the wing tip and designed to protect the wing from contact with the ground. (Fig. 1.)

SHOCK ABSORBER.—A spring or elastic member, designed to prevent the imposition of large accelerations on the structure of the airplane when landing or taking off. Shock absorbers are usually interposed between the wheels, floats, or tail skid and the remainder of the airplane to secure resiliency in landing and taxying. (Fig. 1.)

(*e*) *DIMENSIONS AND CHARACTERISTICS.*

ANGLE, LANDING.—The acute angle between the upper wing chord of an airplane and the horizontal when it is resting on the ground in its normal position. (Also called "Ground angle.") (Fig. 1.)

ANGLE OF WING SETTING.—The acute angle between the plane of the wing chords and the propeller axis. Its symbol is i_w. (Also called "Angle of incidence of wing.") (Fig. 1.)

ANGLE OF STABILIZER SETTING.—The acute angle between the chord of the lower wings of an airplane and the chord of the stabilizer. This angle is denoted by the symbol β and is positive when the stabilizer has a greater angle of incidence than the wing. (Also called "Longitudinal dihedral" or "Longitudinal V.") (Fig. 1.)

DECALAGE.—The acute angle between the wing-chords of a biplane or multiplane. (Fig. 1.)

DIHEDRAL ANGLE.—The acute angle between the wing and the lateral axis of the airplane projected on a plane perpendicular to the longitudinal axis of the airplane. In certain types of wings it is necessary to specify whether the upper or the lower surface is taken, and a special definition would be required for a warped wing. If the inclination of the wing is upward, the angle is said to be positive; if downward, negative. (Fig. 1.) The several main supporting surfaces of an airplane may have different amounts of dihedral. The dihedral angle has the symbol γ.

GAP.—The distance between the planes of the chords of the upper and lower wings of a biplane, measured along a line perpendicular to the chord of the upper wing at any designated point of its leading edge. (Fig. 1.) Its symbol is G.

MEAN CHORD OF A WING.—The quotient obtained by dividing the wing area by the extreme dimension of the wing projection at right angles to the chord.

MEAN CHORD OF A COMBINATION OF WINGS.—The ratio

$$\frac{c_1S_1+c_2S_2+c_3S_3+\ \ldots\ldots}{S_1+S_2+S_3+\ \ldots\ldots}$$

where c_1, c_2, c_3, etc., are the mean chords of the various wings, and S_1, S_2, S_3, etc., are their areas.

OVERHANG.—One-half the difference in the span of any two main supporting surfaces of an airplane. The overhang is positive when the upper of the two main supporting surfaces has the larger span. (Fig. 1.)

SWEEP BACK.—The acute angle between the lateral axis of an airplane and the projection of the leading edge of the wing on a plane which includes the lateral and longitudinal axes. (Fig. 1.)

F. TERMS RELATING TO AIRPLANES—Continued.

(*e*) *DIMENSIONS AND CHARACTERISTICS*—Continued.

RAKE.—The cutting away of the wing tip at an angle so that the plan form of the main supporting surfaces is trapezoidal. The amount of rake is measured by the acute angle between the straight portion of the wing-tip outline and the plane of symmetry. The rake is positive when the trailing edge is longer than the leading edge. (Fig. 1.)

SPAN.—The maximum distance measured parallel to the lateral axis from tip to tip of an airplane wing, inclusive of ailerons. (Fig. 1.)

STAGGER.—The amount of advance of the leading edge of an upper wing of a biplane, triplane, or multiplane over that of a lower, expressed either as percentage of gap or in degrees of the angle whose tangent is the percentage just referred to. It is considered positive when the upper wing is forward, and is measured from the leading edge of the upper wing along its chord to the point of intersection of this chord with a line drawn perpendicular to the chord of the upper wing at the leading edge of the lower wing, all lines being drawn in a plane parallel to the plane of symmetry. (Fig. 1).

WASHIN.—Permanent warping of the wing which results in an increase in the angle of attack near the tip.

WASHOUT.—Permanent warping of a wing which results in a decrease in the angle of attack near the tip.

WING LOADING.—The gross weight of an airplane, fully loaded, divided by the area of the supporting surface. The area used in computing the wing loading should include ailerons, but not the stabilizer or elevators.

LENGTH OF FUSELAGE.—The distance from the nose of the fuselage (including the engine bed and radiator, if present) to the after end of the fuselage, not including the control and stabilizing surfaces.

OVER-ALL LENGTH.—The distance from the extreme front to the extreme rear of an aircraft, including the propeller and the tail unit.

G. TERMS COMMON TO AEROSTATS AND AIRPLANES.

(*a*) *PARTS.*

RIGGER.—One who is employed in assembling and aligning aircraft.

RIGGING.—The assembling, adjusting, and aligning of the parts of an airplane, or the attachment and adjustment of the car, rudders, valves, controls, etc., of an airship.

CONTROLS.—A general term applying to the means provided to enable the pilot to control the speed, direction of flight, attitude, and power of an aircraft.

CONTROL COLUMN OR YOKE.—A control lever with a rotatable wheel mounted at its upper end. (*See* Control stick.) Pitching is controlled by fore-and-aft movement of the column; rolling, by rotation of the wheel.

"Wheel (or dep) control" is that type of control in which such a column or yoke is used.

CONTROL STICK.—The vertical lever by means of which the longitudinal and lateral controls of an airplane are operated. Pitching is controlled by a fore-and-aft movement of the stick, rolling by a side-to-side movement. (Fig. 1.)

"Stick control" is that type of control in which such a stick is used.

RUDDER BAR.—The foot bar by means of which the control cables leading to the rudder are operated. (Fig. 1.)

CONTROL SURFACE.—A movable surface designed to be rotated or otherwise moved by the pilot in order to change the attitude of the airplane or airship.

BALANCED SURFACE.—A control surface which extends on both sides of the axis of the hinge or pivot in such a manner as to reduce the moment of the air forces about the hinge. (Figs. 1, 3, 4, and 5.)

G. TERMS COMMON TO AEROSTATS AND AIRPLANES—Continued.

(*a*) *PARTS*—Continued.

HORN.—The operating lever of a control surface of an aircraft; e. g., aileron horn, rudder horn, elevator horn. (Figs. 1, 3, and 4.)

STABILIZER.—A normally fixed surface at the rear end of an aircraft, approximately parallel to the plane of the longitudinal and lateral axes, whose function is to stabilize the pitching motion. (Also called "Tail plane.") (Fig. 1.)

RUDDER.—A movable auxiliary surface, usually attached at the rear end of an aircraft, the function of which is to impress a yawing moment upon the aircraft. (Figs. 1, 3, 4, and 5.)

ELEVATOR.—A movable auxiliary surface, usually hinged to the stabilizer, the function of which is to impress a pitching moment on the aircraft. (Figs. 1, 3, 4, and 5.)

TAIL GROUP (or TAIL UNIT).—The stabilizing and control surfaces at the rear end of an aircraft, including stabilizer, fin, rudder, and elevator. (Also called "Empennage.")

FINS.—Small fixed surfaces, attached to different parts of aircraft, parallel to the longitudinal axis, in order to secure stability; for example, tail fins, skid fins, etc. Fins are in the great majority of cases substantially vertical, and are sometimes adjustable. (Fig. 1, 3, 4, 5, 6, 9, 10, and 14.)

INSPECTION WINDOW.—A small transparent window fitted in the envelope of a balloon or airship, or in the wing of an airplane, to allow inspection of the interior. (Figs. 1 and 3.)

(*b*) *PERFORMANCE AND CONDITIONS OF FLIGHT.*

AIRSPEED.—The speed of an aircraft relative to the air. Its symbol is V.

GROUND-SPEED.—The horizontal component of the velocity of an aircraft relative to the earth.

FLIGHT PATH.—The path of the center of gravity of an aircraft with reference to the earth.

LEEWAY.—The lateral velocity of an aircraft caused by horizontal air currents.

DRIFT.—The lateral velocity of an aircraft, due to air currents or other causes.

DRIFT ANGLE.—The angular deviation of an aircraft from a set course.

RELATIVE WIND.—The motion of the air with reference to a body; i. e., its motion as observed by a man at rest on the body. The direction and velocity of the relative wind, therefore, are found by adding two vectors, one being the velocity of the air with reference to the earth, the other being equal and opposite to the velocity of the body with reference to the earth.

RATE OF CLIMB.—The vertical component of the airspeed of an aircraft; i. e., its vertical velocity with reference to the air.

ENDURANCE.—The maximum length of time an aircraft can remain in the air at a given speed at a stated altitude. Full speed and sea level are implied when the word is used without specifications.

MANEUVERABILITY.—That quality in an airplane which makes it possible for the pilot to change its attitude rapidly.

CONTROLLABILITY.—The quality in an airplane which makes it possible for the pilot to change its attitude easily and with the exertion of little force.

WASH.—The disturbance in the air produced by the passage of an airfoil. (Also called the "wake," in the general case for any solid body.)

G. TERMS COMMON TO AEROSTATS AND AIRPLANES—Continued.

(*b*) *PERFORMANCE AND CONDITIONS OF FLIGHT*—Continued.

LOAD:

DEAD.—The structure, power plant, and fixed equipment of an aircraft. Included in this fixed equipment are the water in the radiator and cooling system, all essential instruments and furnishings, fixed electric wiring for lighting, heating, etc., and also, in the case of an aerostat, the amount of ballast which must be carried to assist in making a safe landing.

FULL.—Dead load plus useful load.

PAY.—That part of the useful load from which revenue is derived, viz, passengers and freight.

USEFUL.—The crew and passengers, oil and fuel, ballast, ordnance and portable equipment.

LOAD FACTOR.—The ratio of the breaking load of a member to the load under conditions of horizontal steady rectilinear flight.

DYNAMIC FACTOR.—The ratio between the load carried by any part of an aircraft when accelerating or when otherwise subjected to abnormal conditions and the load carried in normal flight, the conditions of such loadings being specified.

FACTOR OF SAFETY.—The ratio of the breaking load of a member to the maximum load which can occur in actual use under specific conditions.

PERFORMANCE TESTING.—The process of determining performance characteristics.

H. MATERIALS AND STRUCTURE.

BALLOON FABRIC.—The finished material, usually rubberized, of which balloon or airship envelopes are made.

BIASED.—Plied fabric in which the threads of the plies are at an angle to each other.

PARALLEL.—Plied fabric in which the threads of the plies are parallel to each other.

PANEL.—The unit piece of fabric of which the envelope of an aerostat is made.

PROOFING.—Material incorporated in the fabric of an aerostat at the time of manufacture, to increase its resistance to the weather and to prevent the passage of gas.

DOPE, AIRPLANE.—The liquid material applied to the cloth surface of airplane members to increase strength, to produce tautness, and to act as a filler which maintains air-tightness.

DOPE, AIRSHIP.—The liquid material applied to airship fabric to increase gas-tightness. In contrast with airplane dope, it does not cause shrinking.

LAMINATED WOOD.—A product formed by gluing or otherwise fastening together individual wood planks or laminations with the grain substantially parallel.

VENEER.—Thin sheets of wood, either sliced with a knife or sawed.

PLYWOOD.—A product formed by gluing together two or more layers of veneer.

WIRE.—In aeronautics refers specifically to drawn solid wire.

STAY.—A wire or other tension member; for example, the stays of the wing and body trussing. (Fig. 1.)

STRUT.—A compression member of a truss frame. For instance, the vertical members of the wing truss of a biplane (interplane struts) and the short vertical and horizontal members separating the longerons (q. v.) in the fuselage. (Fig. 1.)

FAIRING.—An auxiliary member or structure whose primary function is to reduce head resistance or drag of the part to which it is fitted, and which does not in general bear any stress.

FITTING.—A generic term for any small metal part used in the structure of an airplane or airship.

I. AIRPORT AND LANDING FIELD TERMS.

AIRPORT.—The terminal of an airway. It provides a tract of land or water so that aircraft may alight with safety, and also offers facilities for operation, such as hangars, shops, supply depots, etc.

HANGAR.—A shelter for housing aircraft.

SHED.—A shelter for housing airships.

LANDING FIELD.—A field of such a size and nature as to permit of airplanes landing and taking off in safety.

LANDING T.—A white mark shaped like the capital letter T laid out on the landing area of a landing field to indicate the direction of the wind for guidance in landing and take-off of airplanes.

WIND CONE.—A sleeve of light fabric shaped like a truncated cone when inflated and suspended by one end from a rigid support. When suitably suspended, if there is a wind it stands out nearly horizontally and indicates its direction: or in the absence of a wind it is not inflated, and thus indicates the fact.

RUNWAY (LANDING FIELD).—A smooth and elongated area on a landing field along which the airplanes alight and take off. Also a temporary surface erected on a landing field when it is muddy or soft to facilitate the take-off and alighting of airplanes.

RUNWAY (HANGAR FOR SEAPLANES).—A firm inclined surface leading from the entrance of a hangar for seaplanes into the water. Seaplanes are beached on this surface and drawn up it for storage in the hangar.

APRON.—An open working surface, with a firm floor, in front of a hangar for the storage or handling of airplanes.

MOORING MAST.—A mast or tower at the top of which there is mounted a fitting so that the bow of an airship may be secured. It is usually provided with a ladder or staircase and a platform at the top so that crew and passengers may enter or leave the airship, and also with piping for the supply of fuel, gas, and water.

BALLOON BED.—A mooring place on the ground for a captive balloon.

GROUND CLOTH.—Canvas placed on the ground to protect an aerostat.

J. AERODYNAMIC TERMS.

(*a*) *AXES, ANGLES, FORCES, ETC.*

AXES OF AN AIRCRAFT.—Three fixed lines of reference, usually centroidal and mutually perpendicular. (Part III.)

The principal longitudinal axis in the plane of symmetry, usually parallel to the axis of the propeller, is called the longitudinal axis; the axis perpendicular to this in the plane of symmetry is called the normal axis; and the third axis, perpendicular to the other two, is called the lateral axis. In mathematical discussions the first of these axes, drawn from front to rear, is called the X axis; the second, drawn upward, the Z axis, and the third, running from right to left, the Y axis.

ATTITUDE.—The position of an aircraft as determined by the inclination of its axes to some frame of reference. If not otherwise specified, this frame of reference is fixed to the earth, and the attitude depends entirely on the position of the aircraft as seen by an observer on the ground.

REYNOLDS NUMBER.—A name given the fraction $\rho\frac{Vl}{\mu}$ in which

ρ is the density of the air;
V is the relative velocity of the air;
l is a linear dimension of the body;
μ is the coefficient of viscosity of the air.

SKIN FRICTION.—The tangential component of the fluid force at a point on a surface.

J. AERODYNAMIC TERMS—Continued.

(*a*) *AXES, ANGLES, FORCES, ETC.*—Continued.

DYNAMIC (OR IMPACT) PRESSURE.—The product $1/2\ \rho\ V^2$ where ρ is the density of the air and V is the relative speed of the air. It is the quantity measured by most airspeed instruments. Its symbol is q.

DYNAMIC LOAD.—Any load due to accelerations of an aircraft, and therefore proportional to its mass.

DRAG.—The component parallel to the relative wind of the total air force on an aircraft or airfoil. Its symbol is D.

The "Absolute drag coefficient" is C_D as defined by the equation $C_D = \frac{D}{qS}$, in which D is the drag, q is the impact pressure $\left(=\frac{1}{2}\rho V^2\right)$ and S is the effective area of the surface upon which the air force acts.

In the case of an airplane, that part of the drag due to the wings is called "wing drag"; that due to the rest of the airplane is called "structural drag" or "parasite resistance."

DRAG, INDUCED.—That portion of the drag which would be experienced in a nonviscous fluid.

LIFT.—The component perpendicular to the relative wind and in the plane of symmetry of the total air force on an aircraft or airfoil. It must be specified whether this applies to a complete aircraft or to parts thereof. (In the case of an airship this is often called "dynamic lift".) Its symbol is L.

The "Absolute lift coefficient" is C_L as defined by the equation $C_L = \frac{L}{qS}$, in which L is the lift, q is the impact pressure $\left(=\frac{1}{2}\rho V^2\right)$ and S is the effective area of the surface upon which the air force acts.

CROSS-WIND FORCE.—The component perpendicular to the lift and to the drag of the total air force on an aircraft or airfoil. Its symbol is C; and its absolute coefficient C_C is defined by $C_C = \frac{C}{qS}$.

ATTACK, ANGLE OF.—The acute angle between the chord of an airfoil and its direction of motion relative to the air. (This definition may be extended to other bodies than airfoils.) Its symbol is α.

CRITICAL ANGLE.—An angle of attack at which the flow about an airfoil changes abruptly, with corresponding abrupt changes in the lift and drag.

PITCH, ANGLE OF.—The acute angle between two planes defined as follows: One plane includes the lateral axis of the aircraft and the direction of the relative wind; the other plane includes the lateral axis and the longitudinal axis. (In normal flight the angle of pitch is, then, the angle between the longitudinal axis and the direction of the relative wind.) This angle is denoted by Θ, and is positive when the nose of the aircraft rises.

ROLL, ANGLE OF (or BANK, ANGLE OF).—The acute angle through which an aircraft must be rotated about its longitudinal axis in order to bring its lateral axis into a horizontal plane. This angle is denoted by Φ, and is positive when the left wing is higher than the right.

YAW, ANGLE OF.—The acute angle between the direction of the relative wind and the plane of symmetry of an aircraft. This angle is denoted by Ψ, and is positive when the aircraft turns to the right.

AILERON ANGLE.—The acute angle between the aileron and the wing. It is positive when the trailing edge is pulled down.

ELEVATOR ANGLE.—The acute angle between the elevator and the stabilizer. It is positive when the trailing edge is pulled down.

J. AERODYNAMIC TERMS—Continued.

(*a*) *AXES, ANGLES, FORCES, ETC.*—Continued.

RUDDER ANGLE.—The acute angle between the rudder and the plane of symmetry of the aircraft. It is positive when the trailing edge moves to the left with reference to the normal position of the pilot.

DOWNWASH ANGLE.—The angle through which an air stream is deflected by any lifting surface of an airplane. It is measured in a plane parallel to the plane of symmetry, and is denoted by the symbol ϵ.

ANGLE, GLIDING.—The acute angle between the horizontal and the path along which an airplane in ordinary flying attitude descends in still air when the propeller is giving no thrust.

ZERO LIFT ANGLE.—The angle of attack of an airfoil when the lift is zero.

ZERO LIFT LINE.—A line through the trailing edge of an airfoil section parallel to the direction of the wind when the lift is zero.

RUDDER TORQUE.—The twisting moment exerted by the rudder on the fuselage. The product of the rudder area by the distance from its center of area to the axis of the fuselage may be used as a relative measure of rudder torque.

(*b*) *MISCELLANEOUS TERMS.*

AIRFOIL.—A winglike structure, flat or curved, e. g., a fin, wing, aileron, rudder, etc. Its function is to cause forces to be exerted perpendicular to its surfaces by the dynamical action of the air through which it moves.

The words "control surface," "lifting surface," and "stabilizing surface" are often used to indicate an airfoil used for a specific purpose.

AIRFOIL SECTION (or PROFILE).—A cross section of an airfoil made by a plane perpendicular to its lateral axis.

Any definite airfoil, even when considered by itself, as in a wind-tunnel experiment, is always designed with reference to a definite position in an aircraft; certain airfoils are to be used horizontally, e. g., wings, ailerons, stabilizer; others vertically, e. g., rudders, fins. In the former case the section (or profile) is the cross section made by the plane of symmetry of the aircraft; in the latter, by a horizontal plane.

LEADING EDGE.—The foremost edge of an airfoil or propeller blade. (Also called entering edge.)

TRAILING EDGE.—The rearmost edge of an airfoil or propeller blade.

CHORD (OF AN AIRFOIL SECTION).—The line of a straight edge brought into contact with the lower surface of the section at two points; in the case of an airfoil having double convex camber, the straight line joining the leading and trailing edges. (These edges may be defined, for this purpose, as the two points in the section which are farthest apart.) (Fig. 1.)

The line joining the leading and trailing edges should be used also in those cases in which the lower surface is convex except for a short flat portion. The method used for determining the chord should always be explicitly stated for those sections with regard to which ambiguity seems likely to arise.

CHORD LENGTH.—The length of the projection of the airfoil section on its chord Its symbol is c.

CAMBER.—The convexity or rise of the curve of an airfoil section from its chord, usually expressed as the ratio of the maximum departure of the curve from the chord to the length of the chord. "Top camber" refers to the upper surface of an airfoil and "bottom camber" to the lower surface; "mean camber" is the mean of these two.

In the case of airfoils having both surfaces convex outward, e. g., portions of a propeller blade, top camber is the maximum distance of the upper surface from the chord, bottom camber is the maximum distance of the lower surface from the chord, camber ratio is the ratio of the maximum thickness of the airfoil to the length of the chord.

J. AERODYNAMIC TERMS—Continued.

(*b*) *MISCELLANEOUS TERMS*—Continued.

SPAN.—The lateral dimension of an airfoil; i. e., its dimension perpendicular to its chord. Its symbol is *b*.

ASPECT RATIO.—The ratio of span to mean chord of an airfoil; i. e., the ratio of the square of the span to the area of an airfoil.

CENTER OF PRESSURE OF AN AIRFOIL SECTION.—The point in the chord of an airfoil section, prolonged if necessary, which is the intersection of the chord and the line of action of the resultant air force. Its abbreviation is *C. P.*

CENTER OF PRESSURE COEFFICIENT.—The ratio of the distance of the center of pressure from the leading edge to the chord length. Its symbol is C_p.

STREAMLINE.—The path of a small portion of a fluid relative to a solid body with respect to which the fluid is moving. The term is commonly used only of such flows as are not eddying, but the distinction should be made clear by the context.

STREAMLINE FLOW.—Flow past a solid body without any discontinuity in the pressure or velocity distribution.

STREAMLINE FORM.—A solid body which produces streamline flow.

WIND TUNNEL.—An elongated chamber through which a steady air stream may be drawn by a suction fan. Models of airfoils of aircraft or of propellers may be placed in the middle portion of the tunnel, called the experimental chamber, and supported by suitable balances placed outside the air stream, so that the forces, moments, etc., due to the moving air may be measured.

(*c*) *STABILITY THEORY.*

STABILITY.—That property of a body which causes it, when disturbed from a condition of equilibrium or steady motion, to develop forces or moments of such a character as to tend to restore the body to its original condition.

AUTOMATIC.—Stability dependent upon movable control surfaces automatically operated by mechanical means.

INHERENT.—Stability of an aircraft due solely to the disposition and arrangement of its fixed parts; i. e., that property which causes it, when disturbed, to return to its normal attitude of flight without the use of controls or the interposition of any mechanical devices.

DIRECTIONAL.—Stability with reference to rotations about the normal axis; i. e., an airplane possesses directional stability in its simplest form if a restoring moment comes into action when it is given a small angle of yaw. Owing to symmetry, directional stability is closely associated with lateral stability.

LATERAL.—Stability with reference to disturbances involving rolling, yawing, or side slipping; i. e., disturbances in which the position of the plane of symmetry of the aircraft is affected.

LONGITUDINAL.—Stability with reference to disturbances in the plane of symmetry; i. e., disturbances involving pitching and variation of the longitudinal and normal velocities.

SPIRAL INSTABILITY.—A type of instability inherent in certain airplanes which becomes evident when the airplane, as a result of a yaw, assumes too great a bank and side slips; the bank continues to increase and the radius of the turn to decrease.

STATICAL STABILITY.—Stability of such a character that if the airplane is displaced slightly from its normal attitude by rotation about an axis through its center of gravity (as may be done in wind tunnel experiments) moments come into play which tend to return the airplane toward its original attitude.

A. *AERODYNAMIC TERMS*—Continued.

(c) *STABILITY THEORY*—Continued.

STABILITY—Continued.

DYNAMICAL STABILITY.—Stability of such a character that if the airplane is displaced from steady motion in flight it tends to return to that steady state of motion, the oscillations due to restoring moments being damped out.

In a general way, the difference between static stability and dynamical stability is that the former depends on restoring moments alone, while the latter includes the action of damping factors.

STABLE OSCILLATION.—An oscillation whose amplitude decreases continuously.

UNSTABLE OSCILLATION.—An oscillation whose amplitude increases continuously till the whole motion is changed.

PHUGOID OSCILLATION.—A long-period oscillation characteristic of the disturbed longitudinal motion of an airplane. This is referred to when it is said that an airplane "hunts."

PERIOD.—The time taken for a complete oscillation.

RIGHTING MOMENT (OR RESTORING MOMENT).—A moment which tends to restore an aircraft to its previous attitude after any small rotational displacement.

DIVERGENCE.—A motion in which, after a disturbance, the body departs continuously without oscillations from its original state of motion.

DAMPED HARMONIC MOTION.—Motion defined by the differential equation

$$a\frac{d^2s}{dt^2}+b\frac{ds}{dt}+c\,s=O,$$

in which

a is the mass (or moment of inertia),
s is the displacement,
b is the coefficient of damping force (or moment),
c is the coefficient of force (or moment) of restitution.

The ratio $\frac{b}{a}$ is called the damping coefficient.

The solution of the equation is

$$s=Ae^{-\lambda t}\sin pt,$$

in which

$$\lambda=-\frac{1}{2}\frac{b}{a},\quad p=\sqrt{\frac{c}{a}-\lambda^2}$$

A is the amplitude at the instant from which time (t) is counted.

DAMPING FACTOR.—The term $e^{-\lambda t}$ in the equation of damped harmonic motion $s=Ae^{-\lambda t}\sin pt$.

LOGARITHMIC DECREMENT.—The product λT where λ is the coefficient appearing in the damping factor of damped harmonic motion and T is the period of the motion $\left(\text{equal to }\frac{2\pi}{p}\right)$.—(*See* Damped harmonic motion.)

RESISTANCE DERIVATIVES.—Quantities expressing the variation of the forces and moments on aircraft due to disturbance of steady motion. They form the experimental basis of the theory of stability, and from them the periods and damping factors of aircraft can be calculated. In the general case there are 18 translatory and 18 rotary derivatives.

ROTARY.—Resistance derivatives expressing the variation of moments and forces due to small changes in the rotational velocities of the aircraft.

TRANSLATORY.—Resistance derivatives expressing the variation of moments and forces due to small increases in the translational velocities of the aircraft.

J. AERODYNAMIC TERMS—Continued.

(*c*) *STABILITY THEORY*—Continued.

RESISTANCE DERIVATIVES—Continued.

LONGITUDINAL.—Resistance derivatives expressing the variation of moments and forces due to small increases in the longitudinal, normal, and pitching velocities.

LATERAL.—Resistance derivatives expressing the variation of moments and forces due to small increases in the lateral, yawing, and rolling velocities.

K. PROPELLER TERMS.

(*a*) *MISCELLANEOUS.*

BLADE FACE.—The surface of a propeller blade which corresponds to the lower surface of an airfoil. (Sometimes called "Thrust face.")

BLADE BACK.—The cambered side of a propeller blade, corresponding to the upper surface of an airfoil.

PROPELLER HUB.—The metal fitting inserted in a wooden propeller for the purpose of mounting it on the engine shaft. (Fig. 1.)

PROPELLER BOSS.—The central portion of a propeller in which the hub is mounted. (Fig. 1.)

PROPELLER ROOT.—That part of the propeller blade near the boss. (Fig. 1.)

TIPPING (OR SHEATHING).—A sheet metal (or equivalent) protective covering of the blade of a propeller near the tip, extended a short distance along the trailing edge and a considerable distance along the leading edge. (Fig. 1.)

PUSHER PROPELLER.—A propeller which is placed at the rear end of its shaft and pushes against the thrust bearing.

TRACTOR PROPELLER.—A propeller which is placed at the forward end of its shaft and pulls on the thrust bearing.

SPINNER.—A fairing, usually made of sheet metal and approximately conical or paraboloidal in form, which is attached to the propeller boss and revolves with it. (Fig. 1.)

INDRAFT (INFLOW).—The flow of air from in front of the propeller into the blades.

SLIPSTREAM.—The stream of air driven astern by the propeller. (The indraft is sometimes included also.)

RACE ROTATION.—The rotation of the air influenced by a propeller. This rotation is much more marked in the slipstream than in front of the propeller.

(*b*) *AERODYNAMICAL.*

PROPELLER SECTION.—A cross-section of a propeller blade made at any point by a plane perpendicular to the blade axis.

PROPELLER CAMBER RATIO.—The ratio of the maximum thickness of a propeller section to its chord.

ASPECT RATIO OF PROPELLER BLADE.—The ratio of propeller radius to maximum blade width.

ANGLE OF PROPELLER BLADE.—The acute angle between the chord of a propeller section and a plane perpendicular to the axis of rotation of the propeller. (Usually "Blade angle.")

BLADE WIDTH RATIO.—The ratio of the developed width of a propeller blade at any point to the circumference of the circle whose radius is the distance of that point from the propeller axis.

TOTAL PROPELLER WIDTH RATIO.—The product of blade width ratio at the point of maximum blade width by number of blades.

PROPELLER RAKE.—The angle which, the line joining the centroids of the sections of a propeller blade makes at the axis, with a plane perpendicular to the axis.

PROPELLER BLADE AREA.—The area of the blade face, exclusive of the boss and the root; i. e., of a portion which is usually taken as extending 0.2 of the radius from the axis of the shaft.

K. PROPELLER TERMS—Continued.

(*b*) *AREODYNAMICAL*—Continued.

PROPELLER DISK AREA, TOTAL.—The total area swept by a propeller; i. e., the area of a circle having a diameter equal to the propeller diameter.

PROPELLER AREA, PROJECTED.—The total disk area less that portion extending 0.2 of the radius from the axis of the shaft.

PROPELLER THRUST.—The component parallel to the propeller axis of the total air force on the propeller. Its symbol is T.

STATIC THRUST.—The thrust developed by a propeller when rotating at a fixed point.

PROPELLER TORQUE.—The moment produced on the propeller by the engine shaft. Its symbol is Q.

PROPELLER INTERFERENCE.—The amount by which the torque and thrust of a propeller are changed by the modification of the air flow in the slipstream produced by bodies placed near the propeller, such as the engine, radiator, etc.

PROPELLER EFFICIENCY.—The ratio of thrust power to power output of a propeller. Its symbol is η.

PROPELLER LOAD CURVE.—A curve representing engine power necessary to drive any given propeller at various speeds. The power required varies directly as the cube of the speed in R. P. M., provided the ratio $\frac{V}{N\,D}$ remains constant.

PITCH OF A PROPELLER.

(*a*) PITCH, AERODYNAMIC.—The distance a propeller would have to advance in one revolution in order that the torque might be zero. Its symbol is p_a.

(*b*) PITCH, EFFECTIVE.—The distance an aircraft advances along its flight path for one revolution of the propeller. Its symbol is p_e.

(*c*) PITCH, GEOMETRICAL.—The distance an element of a propeller would advance in one revolution if it were moving along a helix of slope equal to its blade angle.

(*d*) PITCH, MEAN GEOMETRICAL.—The mean of the geometrical pitches of the several elements. Its symbol is p_g.

(*e*) PITCH, STANDARD.—The geometrical pitch taken at two-thirds of the radius. (Also called "Nominal pitch".) Its symbol is p_s.

(*f*) PITCH, VIRTUAL.—The distance a propeller would have to advance in one revolution in order that there might be no thrust. (Also called "Experimental mean pitch".) Its symbol is p_v.

PITCH RATIO.—The ratio of the pitch to the diameter.

PITCH SPEED.—The product of the mean geometrical pitch by the number of revolutions of the propeller in unit time; i. e., the speed the aircraft would make if there were no slip.

EFFECTIVE HELIX ANGLE.—The angle whose tangent is the ratio of the velocity of flight to the product of the three quantities: 2π, r, the distance from the axis to the point in question, and n, the number of revolutions per second; i. e., $\Phi = \tan^{-1}\left(\frac{V}{2\pi rn}\right)$.

SLIP.—The difference between the mean geometrical pitch and the effective pitch. Slip is usually expressed as a percentage of the mean geometrical pitch.

SLIP FUNCTION.—The ratio of speed of advance through the undisturbed air to the product of propeller diameter by the number of revolutions in unit time. The slip function is the primary factor controlling propeller performance; i. e., $\left(\frac{V}{N\,D}\right)$.

L. INSTRUMENTS AND AUXILIARY APPARATUS.

ALTIMETER.—An aneroid barometer whose dial is marked to indicate altitude.

ALTIGRAPH.—An instrument usually the same in principle as an aneroid barometer which makes on a chart a permanent record of the altitude. The chart is usually graduated in feet or meters in accordance with some empirical pressure altitude formula.

BAROGRAPH.—An instrument usually the same in principle as an aneroid barometer which makes on a chart a permanent record of the variations of barometric pressure.

ANEMOMETER.—An instrument for measuring directly or indirectly the velocity of the wind.

AIRSPEED INDICATOR.—An instrument for indicating the speed of aircraft relative to the air.

TRUE AIRSPEED INDICATOR.—An instrument, usually working on the principle of the Biram or Robinson anemometers, which gives the true airspeed provided the slip of the anemometer is negligible.

APPARENT AIRSPEED INDICATOR.—An instrument, usually dependent on the impact pressure of the airstream, whose readings, therefore, vary both with the true airspeed and with the density of the air.

PITOT TUBE.—A cylindrical tube with an open end, designed to be used with the open end pointing upstream to detect the impact pressure of a fluid stream. When used on aircraft it is associated either with a closed coaxial tube surrounding it or with a closed tube placed near it and parallel to it. The associated tube has perforations in its side, and the air inside is subjected to static pressure, as distinct from impact pressure. The speed of the fluid can be determined from the difference between the impact pressure and the static pressure, as read by a suitable gauge. (Fig. 7.)

VENTURI TUBE.—A short tube with flaring ends and a constriction between them, into which a side tube opens. When fluid flows through the Venturi there is a reduction of pressure in the constriction, the amount of the reduction being a function of the velocity of flow. The reduced pressure may be measured by means of the side tube. (Fig. 8.)

The Venturi is usually combined with a Pitot tube or with one giving static pressure to form a pressure nozzle, which may be used to determine the speed of an aircraft through the air.

PRESSURE NOZZLE.—The apparatus which, in combination with a gauge, is used to measure the pressure due to speed through the air. It may be a Pitot or a Venturi tube, or a combination of the two. Pressure nozzles of various types are also used in yawmeters and other instruments.

YAWMETER.—An instrument giving by direct reading the angle of yaw.

INCLINOMETERS:

ABSOLUTE.—An instrument giving the attitude of an aircraft with reference to the vertical.

RELATIVE.—An instrument giving the attitude of an aircraft with reference to apparent gravity, i. e., to the resultant of the acceleration of the aircraft and gravity. Such instruments are sometimes incorrectly referred to as banking indicators.

TURN INDICATOR.—An instrument indicating when the direction of the line of flight, or of its projection on a horizontal plane, is changing.

TURN METER.—An instrument similar to a turn indicator but which gives quantitatively the rate of turn in terms of the angular velocity or the radius of curvature.

DRIFT METER.—An instrument for the measurement of the angular deviation of an aircraft from a set course.

L. INSTRUMENTS AND AUXILIARY APPARATUS—Continued.

STATOSCOPE.—An instrument used to detect the existence of the minute changes of atmospheric pressure corresponding to small vertical motions of an aircraft.

RATE-OF-CLIMB METER.—An instrument to measure the vertical component of the velocity of an aircraft. Most rate-of-climb meters depend on the rate of change of the atmospheric pressure.

VERTIMETER.—An instrument indicating on a scale the minute changes of atmospheric pressure corresponding to small vertical motions of aircraft.

KYMOGRAPH.—An instrument for recording the rotary motions of an airplane in flight. In general its action depends upon a gyroscope or it makes use of a beam of sunlight focused on a moving film.

LEAK DETECTOR.—An instrument which detects the presence of hydrogen and other light gases in the air, and which can be adapted to find leaks in a container inflated with such a gas.

STABILIZER, MECHANICAL.—A mechanical device to prevent an aircraft from departing from a condition of steady motion, or, in case such a motion is disturbed, to restore it to its steady state. Includes gyroscopic stabilizers, pendulum stabilizers, inertia stabilizers, etc.

WINDMILL.—An air-driven screw fitted with blades somewhat similar to those of a propeller and used to drive auxiliary apparatus.

M. ENGINE TERMS.[1]

(*a*) *TYPES OF ENGINES.*

BARREL-TYPE ENGINE.—An engine having its cylinders arranged equidistant from and parallel to the main shaft.

BIROTARY ENGINE.—An engine having its cylinders arranged in any manner around the crank-shaft, as in a radial or barrel-type engine, the cylinder unit and the crank-shaft unit rotating in opposite directions.

FAN-TYPE ENGINE.—An engine having its cylinders arranged in a radial direction but occupying less than the full circle.

LEFT-HAND ENGINE.—An engine having a propeller shaft which, to an observer facing the propeller hub, rotates in a clockwise direction.

RADIAL ENGINE.—An engine having stationary cylinders arranged radially around a common crank-shaft.

RIGHT-HAND ENGINE.—An engine having a propeller shaft which, to an observer facing the propeller hub, rotates in a counter-clockwise direction.

ROTARY ENGINE.—An engine having its cylinders arranged in any manner around the crank-shaft, as in a barrel or radial engine, the cylinder units revolving around the crank-shaft which is stationary.

SUPERCHARGED ENGINE.—An engine with equipment which enables a greater weight of charge to be furnished than would normally be induced.

VARIABLE COMPRESSION ENGINE.—An engine provided with mechanical means for varying the volume of the compression space.

[1] The engine terms incorporated in this nomenclature are limited to those peculiar to aeronautics. For other engine terms common to automobile engines, see report prepared by nomenclature division, Society of Automotive Engineers.

M. ENGINE TERMS—Continued.

(*b*) *SUPERCHARGERS.*

SUPERCHARGER.—A device for compressing the air supply of aircraft engines, usually intended to maintain normal sea level pressure at the carburetor for all altitudes below a designed limiting value.

CENTRIFUGAL-TYPE.—A supercharging device comprising one or more high-speed rotors operating in a casing provided with diffusion vanes and usually also with entry guide vanes.

FAN-TYPE.—A supercharging device comprising one or more high-speed fan rotors operating in a casing not provided with diffusion or entry vanes.

POSITIVE BLOWER-TYPE.—A supercharging device comprising one or more relatively slow-speed rotors revolving in a stationary case in such a way as to provide a positive displacement.

POSITIVE DRIVEN-TYPE.—A supercharger driven at a fixed-speed ratio from the engine shaft by gears or other positive means.

(*c*) *MISCELLANEOUS TERMS.*

CONSUMPTION PER B. H. P. HOUR.—The quantity of fuel or oil consumed per hour by an engine divided by the uncorrected brake horsepower developed, unless specifically stated otherwise.

DRY WEIGHT.—The weight of an engine, including carburetors, propeller hub assembly, and ignition system complete, but excluding exhaust manifolds, oil, and water.

HORSEPOWER OF AN ENGINE, MAXIMUM.—The maximum horsepower which can be safely maintained for periods not less than five minutes.

HORSEPOWER OF AN ENGINE, NORMAL.—The highest horsepower which can be safely maintained for long periods.

REVOLUTIONS, MAXIMUM.—The maximum number of revolutions per minute that may be maintained for periods not less than five minutes.

REVOLUTIONS, NORMAL.—The highest number of revolutions per minute that may be maintained for long periods.

WEIGHT PER HORSEPOWER.—The dry weight of an engine divided by the normal horsepower.

REPORT No. 157.

NOMENCLATURE FOR AERONAUTICS.

By the National Advisory Committee for Aeronautics.

PART III.

AERONAUTICAL SYMBOLS.

1. FUNDAMENTAL AND DERIVED UNITS.

	Symbol.	Metric.		English.	
		Unit.	Symbol.	Unit.	Symbol.
Length	l	meter	m.	foot (or mile)	ft. (or mi.).
Time	t	second	sec.	second (or hour)	sec. (or hr.).
Force	F	weight of one kilogram	kg.	weight of one pound	lb.
Power	P	kg.m/sec		horsepower	HP
Speed		m/sec	m. p. s.	mi/hr	M. P. H.

2. GENERAL SYMBOLS, ETC.

Weight, $W=mg$.

Standard acceleration of gravity, $g=9.806\text{m/sec.}^2=32.172\text{ft/sec.}^2$

Mass, $m=\frac{W}{g}$

Density (mass per unit volume), ρ

Standard density of dry air, 0.1247 (kg.-m.-sec.) at 15.6°C. and 760 mm. = 0.00237 (lb.-ft.-sec.)

Specific weight of "standard" air, $1.223\text{ kg/m.}^3 = 0.07635\text{ lb/ft.}^3$

Moment of inertia, mk^2 (indicate axis of the radius of gyration, k, by proper subscript).

Area, S; wing area, S_w, etc.

Gap, G

Span, b; chord length, c.

Aspect ratio $=b/c$

Distance from c. g. to elevator hinge, f.

Coefficient of viscosity, μ.

3. AERODYNAMICAL SYMBOLS.

True airspeed, V

Dynamic (or impact) pressure, $q=\frac{1}{2}\rho V^2$

Lift, L; absolute coefficient $C_L=\frac{L}{qS}$

Drag, D; absolute coefficient $C_D=\frac{D}{qS}$

Cross-wind force, C; absolute coefficient $C_c=\frac{C}{qS}$.

Resultant force, R

(Note that these coefficients are twice as large as the old coefficients L_a, D_a.)

Angle of setting of wings (relative to thrust line), i_w

Angle of stabilizer setting with reference to thrust line i_t

Dihedral angle, γ

Reynolds Number $=\rho\frac{Vl}{\mu}$, where l is a linear dimension.

e. g., for a model airfoil 3 in. chord, 100 mi/hr., normal pressure, 0°C: 255,000 and at 15.6°C, 230,000;

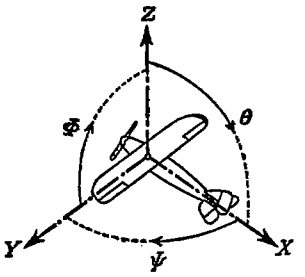
or for a model of 10 cm. chord, 40 m/sec., corresponding numbers are 299,000 and 270,000.

Center of pressure coefficient (ratio of distance of C. P. from leading edge to chord length), C_p.

Angle of stabilizer setting with reference to lower wing. $(i_t - i_w)=\beta$

Angle of attack, α

Angle of downwash, ϵ



Positive directions of axes and angles (forces and moments) are shown by arrows.

Axis.		Force (parallel to axis) symbol.	Moment about axis.			Angle.		Velocities.	
Designation.	Symbol.		Designation.	Symbol.	Positive direction.	Designation.	Symbol.	Linear (component along axis).	Angular.
Longitudinal....	X	X	rolling.....	L	$Y \longrightarrow Z$	roll.....	Φ	u	p
Lateral.....	Y	Y	pitching...	M	$Z \longrightarrow X$	pitch....	Θ	v	q
Normal.....	Z	Z	yawing.....	N	$X \longrightarrow Y$	yaw.....	Ψ	w	r

Absolute coefficients of moment

$$C_l = \frac{L}{q\,b\,S} \quad C_m = \frac{M}{q\,c\,S} \quad C_n = \frac{N}{q\,f\,S}$$

Angle of set of control surface (relative to neutral position), δ. (Indicate surface by proper subscript.)

4. PROPELLER SYMBOLS.

Diameter, D

Pitch (a) Aerodynamic pitch, p_a
(b) Effective pitch, p_e
(c) Mean geometric pitch, p_g
(d) Virtual pitch, p_v
(e) Standard pitch, p_s

Pitch ratio, p/D

Inflow velocity, V'

Slipstream velocity, V_s

Thrust, T

Torque, Q

Power, P
(If "coefficients" are introduced all units used must be consistent.)

Efficiency $\eta = T\,V/P$

Revolutions per sec., n; per min., N

Effective helix angle $\Phi = \tan^{-1}\left(\frac{V}{2\pi r n}\right)$

5. NUMERICAL RELATIONS.

1 HP = 76.04 kg. m/sec. = 550 lb. ft/sec.
1 kg. m/sec. = 0.01315 HP
1 mi/hr. = 0.44704 m/sec.
1 m/sec. = 2.23693 mi/hr.

1 lb. = 0.45359 kg.
1 kg. = 2.20462 lb.
1 mi. = 1609.35 m. = 5280 ft.
1 m. = 3.28083 ft.

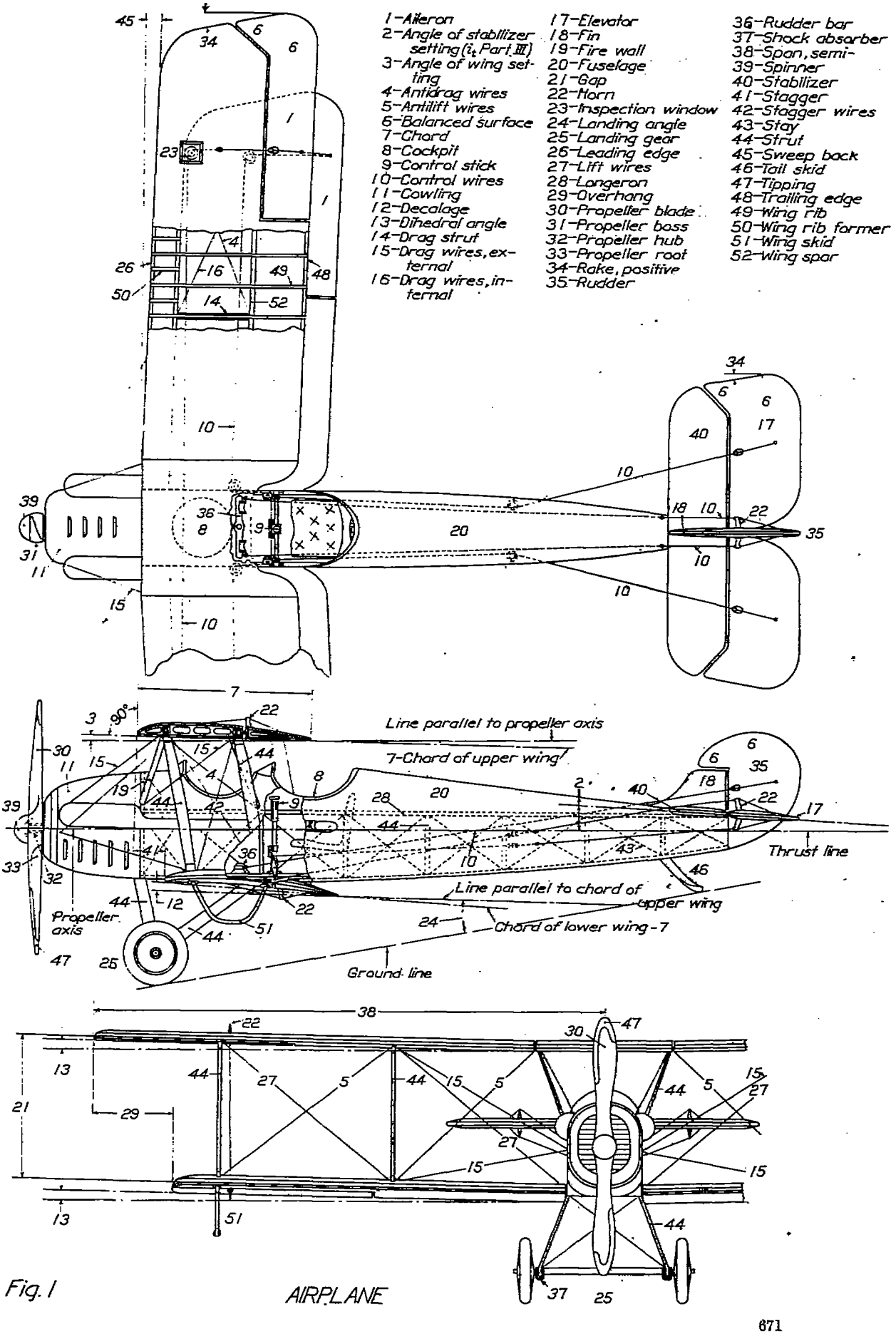
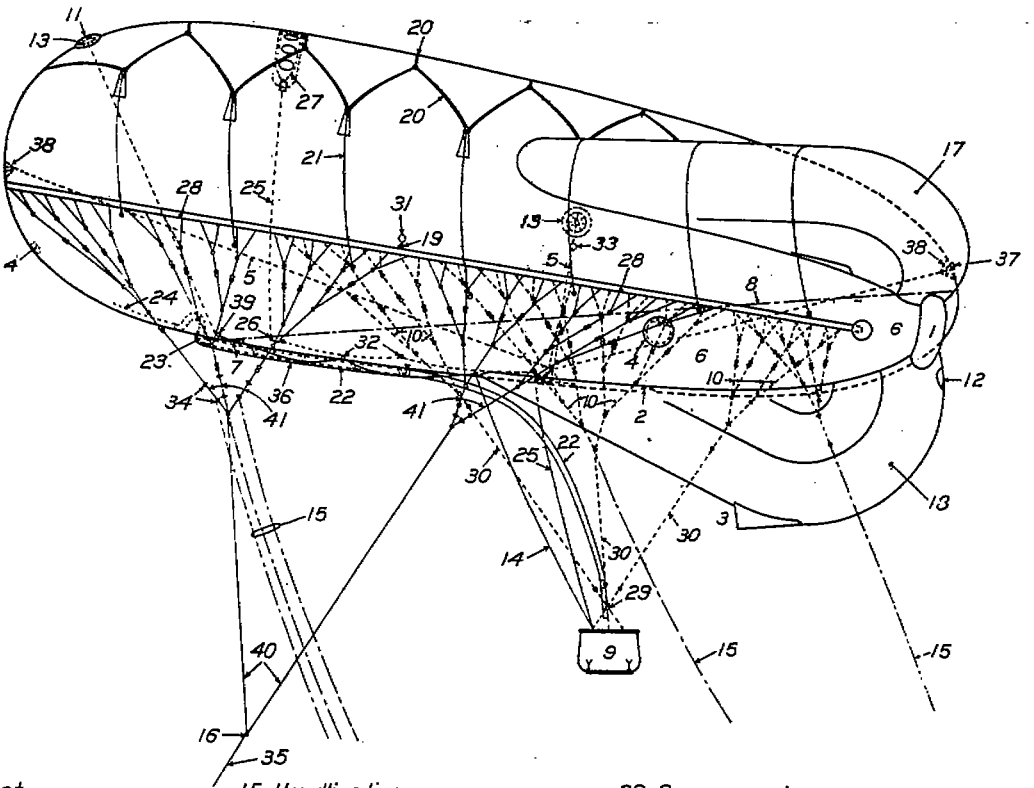
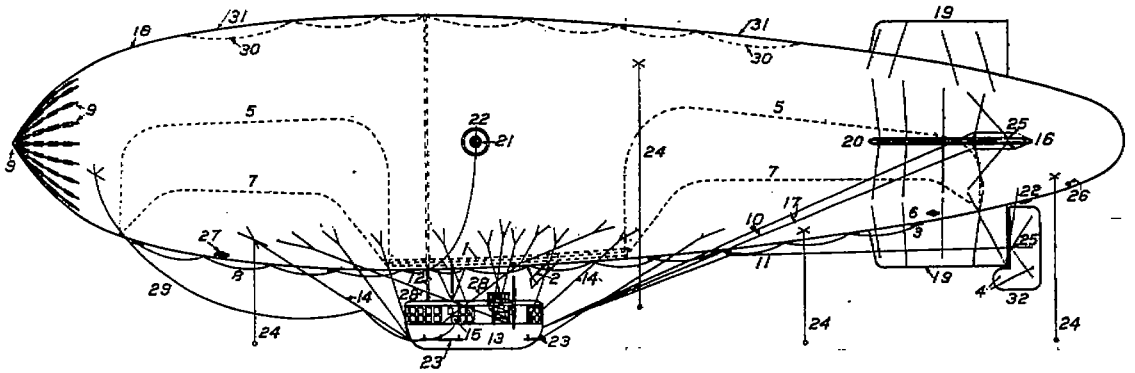


Fig. 1 AIRPLANE



1-Air duct
2-Air opening into ballonet
3-Air scoop
4-Appendix manhole
5-Automatic valve rigging
6-Ballonet
7-Ballonet deflation hole
8-Ballonet diaphragm seam
9-Basket
10-Basket suspension
11-Bonnet (valve cover)
12-Deflation sleeve
13-Gas valve
14-Hand valve line
15-Handling lines
16-Junction piece
17-Lobe, lateral; stabilizer
18-Lobe, vertical; stabilizer
19-Manometer tube attachment
20-Mooring bands
21-Mooring ropes
22-Nursing tube
23-Nursing tube check valve
24-Nursing tube discharge tube
25-Rip cord
26-Rip cord gland
27-Rip panel
28-Suspension band
29-Suspension bar
30-Suspension lines
31-Tie patch for manometer tube
32-Tie patch for rip cord and valve line
33-Tie patch for internal valve line
34-Toggle
35-Towing or traction cable
36-Tube cover
37-Valve adjusting gland
38-Valve cord attachment pyramid
39-Valve gland
40-"V" wires (steel)
41-Winch suspension

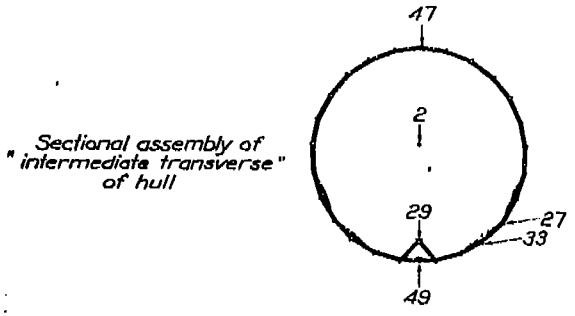
Fig. 2. KITE BALLOON



1-Air pipe to ballonet
2-Air scoop
3-Air valve
4-Balanced surface
5-Ballonet
6-Ballonet manhole
7-Ballonet seam
8-Ballonet valve cord
9-Bow cap and stiffeners
10-Cables, elevator control
11-Cables, rudder control
12-Cables, valve operating
13-Car
14-Car suspension
15-Drag rope stowage
16-Elevator (balanced)
17-Elevator control cable fairlead
18-Envelope
19-Fin, vertical
20-Fin, horizontal
21-Gas manhole
22-Gas valve
23-Hand rail
24-Handling lines
25-Horn (rudder, elevator)
26-Inflation sleeve
27-Inspection window
28-Martingales
29-Mooring line
30-Rip cord
31-Rip panel
32-Rudder (balanced)

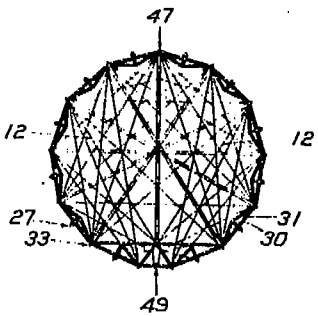
Fig.3 NONRIGID AIRSHIP

X3006—23——44

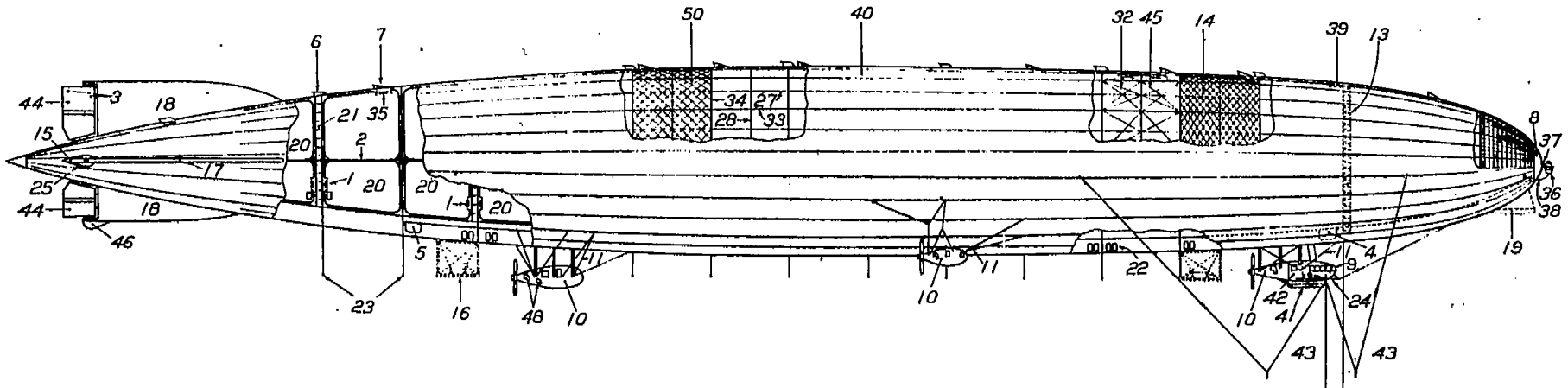


Sectional assembly of "intermediate transverse" of hull

26-Hull; Parts numbered 2,8,12,14,27,28, 29,30,31,32,33, 34,40,45,47,49, 50



Sectional assembly of "main transverse" of hull



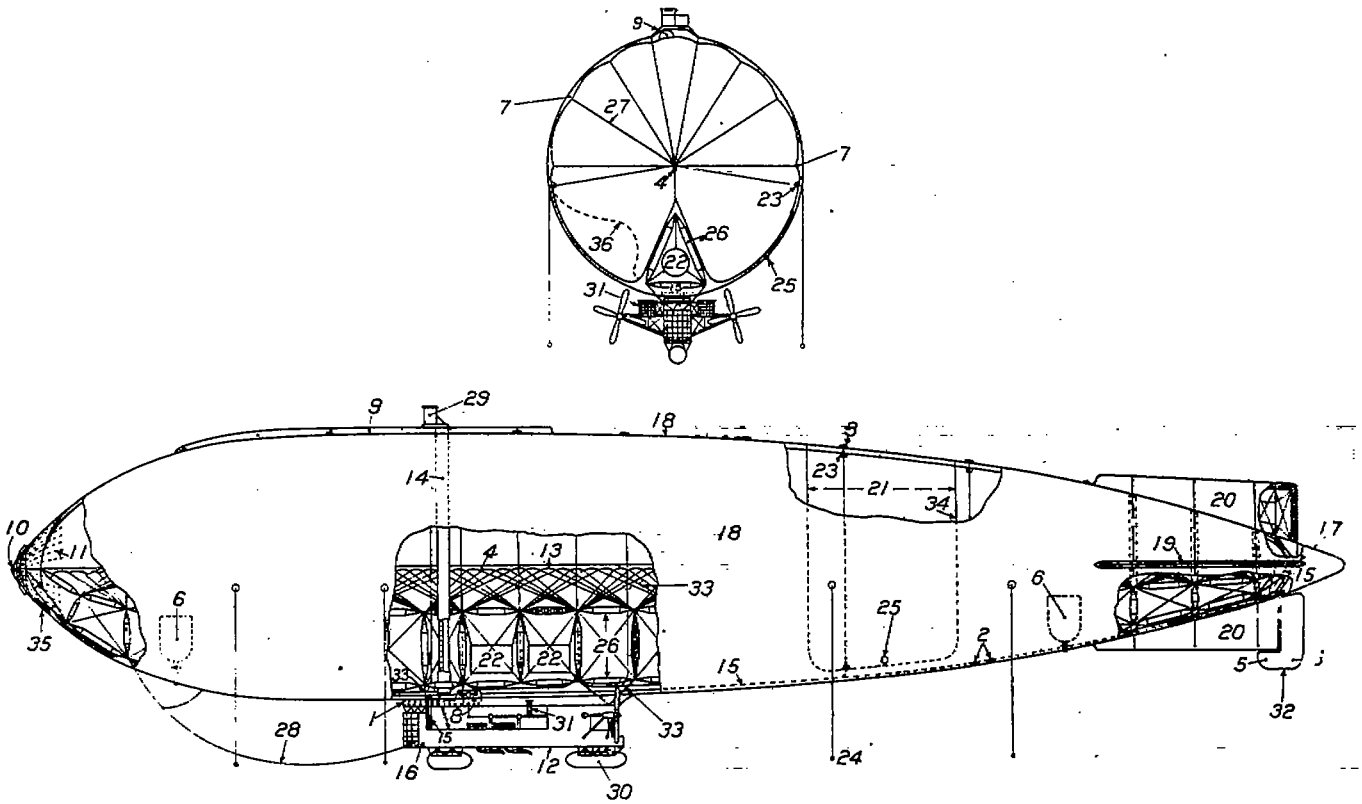
1-Automatic valve (gas)
2-Axial cable, continuous through gas cells from bow to stern
3-Balanced surface
4-Ballast bag (water)
5-Ballast bag (water) emergency
6-Bonnet over gas outlet trunk
7-Bonnet over maneuvering valve
8-Bow cap
9-Car, control
10-Car, power
11-Car, suspension
12-Chord wires
13-Climbing shaft
14-Cord netting, between gas cell and wire netting
15-Elevator (balanced)
16-Field handling frame

17-Fin, horizontal
18-Fin, vertical
19-Gangway
20-Gas container
21-Gas outlet trunk
22-Gasoline tank
23-Handling lines
24-Hand rail
25-Horn
26-Hull
27-Intermediate longitudinal
28-Intermediate transverse
29-Keel apex girder
30-King post
31-King post brace
32-Main diagonal wiring
33-Main longitudinal
34-Main transverse

35-Maneuvering valve (gas)
36-Mooring cone
37-Mooring cone outrigger
38-Mooring lines
39-Observation platform
40-Outer cover
41-Pneumatic bumper
42-Radio room
43-Radio antenna
44-Rudder (balanced)
45-Secondary diagonal wiring
46-Skid
47-Top center-line girder
48-Ventilators
49-Walk-way girder
50-Wire netting, between cord netting and metallic framework

Fig.4

RIGID AIRSHIP



1-Air duct
2-Air valve
3-Automatic and manual valve (gas)
4-Axial suspension band
5-Balanced surface
6-Ballast (water)
7-Ballonet
8-Ballonet blower
9-Bonnet over gas valves
10-Bow cap
11-Bow stiffeners
12-Car (control and power)
13-Catenary
14-Climbing shaft
15-Control cables
16-Drag rope (stowage)
17-Elevator (balanced)
18-Envelope
19-Fin (horizontal)
20-Fin (vertical)
21-Gas container
22 Gasoline tank
23 Gland
24 Handling lines
25 Inflation sleeve
26-Keel, continuous from bow to stern (articulated).
27-Longitudinal diaphram
28-Mooring line
29-Observation platform
30-Pneumatic bumper
31-Radiator
32-Rudder (balanced)
33-Suspension wires
34-Transverse diaphram
35-Ventilator
36-Wall of gas cell under partial deflation

Fig.5 SEMIRIGID AIRSHIP

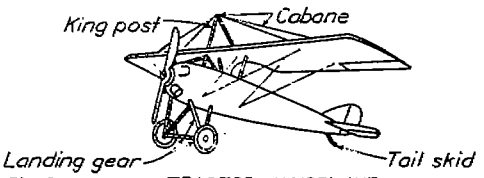


Fig.6. TRACTOR MONOPLANE

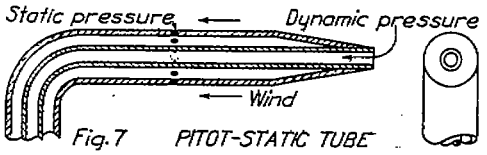


Fig.7 PITOT-STATIC TUBE

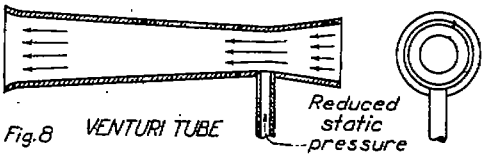


Fig.8 VENTURI TUBE

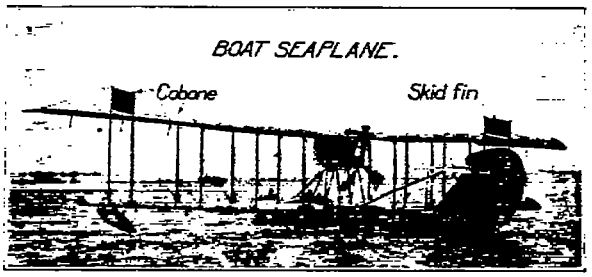


FIG. 9.—Boat seaplane

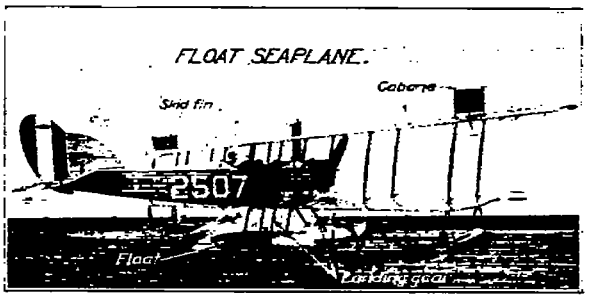


FIG. 10.—Float seaplane.

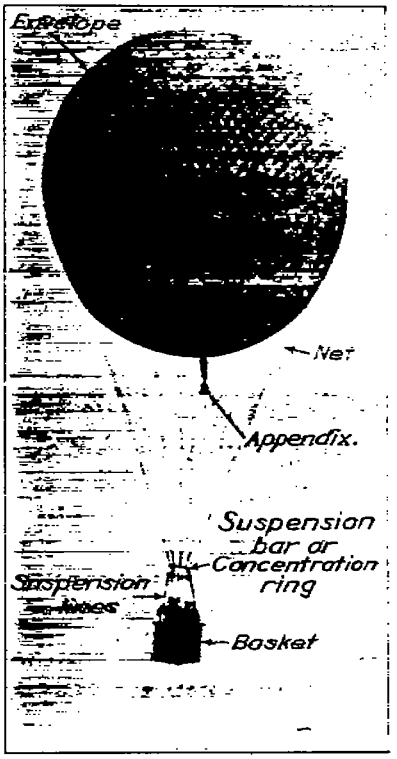


FIG. 11.—Free balloon

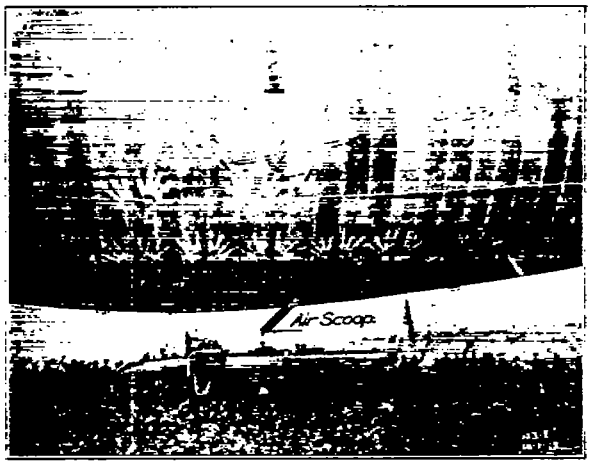


FIG. 12.—Air scoop and patch.

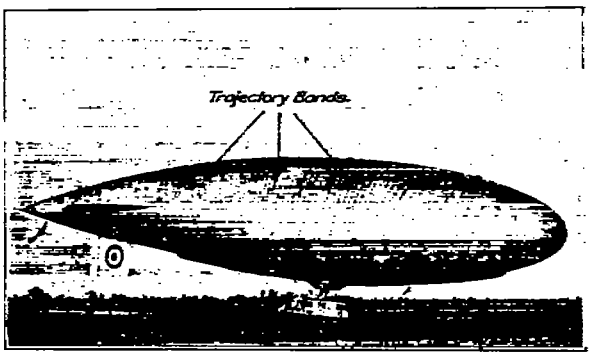


FIG. 13.—Trajectory bands.

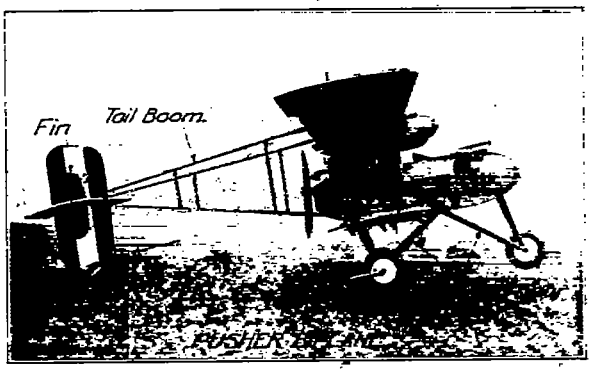


FIG. 14.—Pusher biplane.

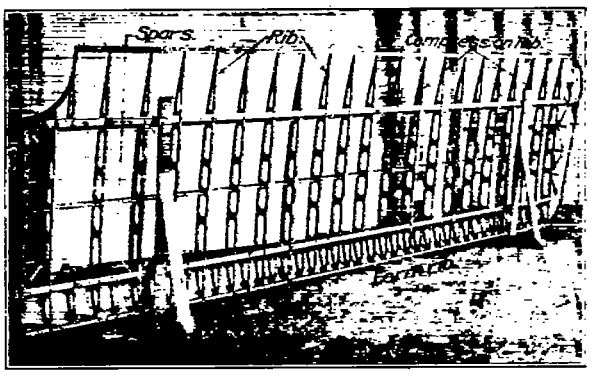


FIG. 15.—Skeleton of wing.